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The American Resin Industry.*

Practically the most important result of the work of the Division of Forestry, during the year 1892, was the proof of the fact that the extraction of resin from the Southern species of pine does not, as commonly supposed, influence the quality of the wood. The opinion, that the timber of trees which have been tapped loses its durability, is not confirmed by chemical analysis, which shows that tapping causes no alteration whatever in the chemical composition of the heartwood, as the turpentine collected all comes from the sapwood, which alone contains it in the fluid form. Nor is there any physiological reason why any such alteration should take place.

It may therefore be asserted with absolute safety that the prejudice of architects and builders against wood which has been tapped is groundless, and this view has been confirmed by actual experiment. Nevertheless, the turpentine industry is the greatest enemy of the forests of the Southern States, although there is no reason why it should be so.

By tapping immature trees and careless tapping a great deal of unnecessary loss is caused; fire, which every year passes through the forests, destroys millions of cubic feet of very valuable timber, the dried resin left on the trees making them most inflammable, and many trees which are not actually consumed by fire are blown down by storms, and become excellent breeding places for destructive insects. For this reason forests, five or six *years after the tapping has ceased, present an appearance of utter* desolation, which extends even to the young growth, so that reproduction is out of the question. In 1890, over 2,000,000 acres of pine forests, tapped for resin, suffered from these evils, and every year the tapping is extended over from 500,000 to 600,000 acres of fresh forest.

*** Abridged translation of an article by Schleicher in the Allgemeine Forst und Jagd Zeitung.**

This state of affairs led the Division of Forestry to undertake a thorough investigation of the whole system of turpentine tapping, the results of which are given below.

The principal minor forest product of the United States is tanning-bark, and next to that comes turpentine, the extraction of which is confined to the pine forests of the Southern States, within a belt about 100 miles broad, bordering the Atlantic and Gulf coast-lines from North Carolina to Louisiana.

This industry covers a large proportion of the world's supply, amounting in value to nearly £2,000,000 annually, but its importance lies even more in its bearing on the future of one of the richest sources of forest wealth in America.

Fernow is of opinion that owing to irrational and wasteful methods, and to the forest fires which are largely consequent thereon, the resin industry, notwithstanding the great value of the outturn is, from an economical point of view, a most unprofitable one. He hopes, by his work, to draw general attention to the methods of working, and to point out the means by which the evils above indicated may be avoided.

"Naval Stores" is the collective name for all resinous products. The name probably has its origin in the fact that these products were formerly mainly used for shipbuilding purposes, which is no longer the case, since iron has largely taken the place of timber.

Resin, or crude turpentine, as obtained from the tree, is a mixture of resin and turpentine, the former being partly dissolved and partly suspended, in the latter. Its consistence varies according to the species of tree from which it comes, the more oil it contains the more fluid it is. "Fine" resin, obtained from the larch, spruce, or balsam, is semi-fluid, more or less transparent and clear, and remains clear when exposed to the air. "Common" resin, the product of other resinous trees, is generally not quite transparent and becomes hard as the oil evaporates. Most kinds of resin are yellow or brown coloured, and turn dark on exposure to the air. They possess a characteristic smell and taste, their specific gravity is nearly 1, and they melt at a low temperature. They are insoluble in water, but dissolve readily in alcohol, ether or oil of turpentine; they contain no nitrogen, little oxygen, and much carbon; they have a slightly acid reaction, and in combination with alkalies, form soap. The best quality is, as a rule, but not necessarily so, the product of the first year's tapping, and is known under the name of "soft white gum," or "virgin dip." In the following year the produce is called "yellow dip," and with every year it becomes darker and loses fluidity. The scrapings, or solidified resin, is the residue which has dried on the tree.

The most important articles of commerce are obtained by the distillation of these products. The first result is oil or spirits of turpentine. When chemically pure it is a mixture of various

hydrocarbons with the formula $C_{10}H_{16}$ while the impure article contains also other hydrocarbons and acids. Rectification is effected by adding lime-water and re-distilling.

Oil of turpentine possesses the following qualities; when freshly made, especially from virgin trees, it is colourless, tasteless, very fluid, and has a peculiar smell, its specific gravity is 0·855 to 0·875, and its boiling point is from 150° to 160° C. Most commercial *oils have a left-handed polarisation. American oil, on the other* hand, is right-handed, which is a simple method of distinction.

The oil is volatile at ordinary temperatures, becomes by oxidation hard and yellow and has an acid reaction. It burns with a very sooty flame, and is insoluble in water, but soluble in alcohol. It is a good solvent for many resins, wax, fats, caoutchouc, sulphur, and phosphorus, and is used in the manufacture of varnish and paint. Mixed with oil it also serves as an illuminant; it is used in medicine, both externally and internally, and probably for the adulteration of many essential oils.

Colophony is the residue after distillation of crude turpentine. Like the latter, its properties vary according to the period of its collection, and it ranges from transparency to complete opacity. The colour runs through all shades from bright yellow to dark brown or nearly black. Some kinds are so soft that they can be scratched with the finger nail, and others are so hard that it requires iron to make any impression. Colophony is nearly without smell or taste, very brittle and easily powdered. It becomes soft at a temperature of about 80° C. and melts between 90° and 100° C. As regards solubility, it resembles raw resin. Its specific gravity is 1·07. It is used in the manufacture of soap, varnish, sealing wax, cement, and paper. In the American market no less than 13 different qualities are recognised.

The following three products are obtained by the dry distillation of colophony:—

(1) Light colophony oil, used for varnishes;

(2) Heavy colophony oil used for printer's ink, lubricating, &c.

These oils which are known in the trade as pale oil, pine oil, printer's oil, &c., are of a red or brown colour, and more or less fluorescent. They have a specific gravity of from 0·98 to 1·00, a faint smell and a characteristic taste. Distillation is carried on over a slow fire and gives 85% of oil. These oils consist of a mixture of hydrocarbons of indeterminate nature and contain as much as 15% of resinous acids. They are insoluble in water, slightly soluble in alcohol and do not saponify, but form unsoluble combinations with slaked lime and other bases. The resin-grease which is produced by the addition of fine slaked lime suspended in water, is a first-rate lubricant. Mixed with palm-oil, colza, or the thicker mineral oils, it is used for the manufacture of lubricating oils. It is also used in the preparation of varnishes and cheap paints,

(3) Common pitch, or the residue of the dry distillation of colophony, is a shining black substance of great brittleness, used by shoemakers and shipbuilders. Pitch can also be made by boiling tar till it has lost one-third or more of its original weight. Pitch of commerce contains more or less inferior colophony and commands a price of about 6 shillings per barrel of 30 gallons.

Brewer's pitch is obtained by stopping the distillation of crude turpentine before all the oil has come over. It contains therefore a certain quantity of turpentine oil. If the latter is in excess, the pitch smokes when melted, and gives a disagreeable sharp taste to the beer, if insufficient in quantity, the pitch is brittle, and scales off in the barrels. The best quality is obtained from the larch, and comes principally from the Tyrol. A good deal of brewer's pitch is also made in the Southern States of North America.

Pine tar is principally obtained by the dry distillation of wood, and most of it comes from North Carolina, where this industry has been vigorously carried on since the earliest colonial times. In the remainder of the Southern Pine Zone, it is only made for home use.

The process of manufacture is as follows. The heartwood of perfectly dry trunks and branches of the long-leaf pine is cut into small pieces, and piled up in a conical heap in a circular basin in the ground lined with clay. The centre of the basin communicates by means of a pipe with a pit in the ground three or four feet distant from the heap. The latter is covered with turf and earth, and is treated in every way like an ordinary charcoal kiln. The flow of tar begins nine or ten days after the kindling of the kiln, and lasts for several weeks. The tar is emptied from the pit into casks of 320 lbs., which as a rule are made of the same kind of wood as the tar. A "cord" of dry wood (2000 lbs.) gives 40 to 50 gallons of tar. The profits of this business are small, but it is carried on at a time when hardly any other work is practicable. The price in Wilmington, N. C., per barrel of 30 gallons was in 1893 about 4/4d. the price having fallen in consequence of the cheaper production of tar as a bye-product of charcoal burning in iron retorts.

Finally tar-oil is a product of the distillation of tar. It is a mixture of hydrocarbons with a little wood spirit and a small quantity of creasote. It has a density of 0·877 and is used as an insecticide, and for external use in domestic and veterinary medicine.

The resin of commerce comes mainly from Austria, France, Corsica, Spain, Portugal, Galicia, Prussia, and the United States. Most of the European turpentines are obtained from *Pinus laricio* and *Pinus maritima,* the former yielding the greatest quantity, especially in Lower Austria, France and Corsica. *Pinus maritima* is principally grown in France, between Bayonne and Bordeaux, where there are 1,500,000 acres of forest.

The larch in South Italy and the Italian Alps gives a resin of first class quality, though only in small quantities per tree per year, which is known in trade as Venetian turpentine. Occasionally, more especially in Galicia and Russia, the spruce and Scot's pine are tapped. The turpentine of the last named species, which is also collected is Alsace, is sold under the name of Strasburg turpentine. Hungarian turpentine is derived from *Pinus pumilio.*

In the United States, at the time of the colonisation, a considerable quantity of resin was collected from the pitch pine (*Pinus rigida*) of the North Atlantic States, but this species is now so nearly exterminated that the industry has practically died out and the manufacture is entirely confined to the South, where three species are found which yield turpentine in large quantities :

(1) Long-leaf pine, *Pinus palustris ;*
(2) Loblolly pine, *Pinus taeda ;*
(3) Cuban pine, *Pinus Cubensis.*

The two last give a fluid resin rich in volatile oil, which on distillation leaves behind only a small quantity of hard colophony. The resin of these two trees flows so readily, that the yield only lasts one season. They are, therefore, considered unworkable, except when they occur mixed with *Pinus palustris.* It is, however, possible, and even probable, that with careful management they may be made more productive and that the stretches of forest of *Pinus taeda* in Arkansas, Louisiana, and Texas, as also the forests of *Cubensis* in Florida, may yet become valuable sources of resin.

At present *Pinus palustris* supplies the principal demand, not only of the United States, but also of the whole world, as the production of France and Russia (which are the only other countries that need be considered) taken together only amounts to one-tenth of the total out-put.

The earliest collection of resin from *Pinus palustris* took place in North Carolina, where, together with the manufacture of pitch and tar, it was a source of income to the first settlers, and in later colonial times became a highly paying industry, supplying an important export trade. During the three years, 1768 to 1770, the export to the mother country amounted to 88,111 barrels, 30 gallons crude turpentine, 20,646 barrels pitch, and 88,366 barrels tar, worth altogether 215,000 dollars. This has gone on increasing up to the present, the value of the exports of resin and turpentine in 1893 being 8,682,000 dollars.

The method of tapping for resin varies with the country and species of tree. Corresponding with the position of the resin in the tree, the following three methods may be distinguished :—

(1) A blaze is made on the tree, which is enlarged every year, and the resin is either collected in a hollow at the foot of the blaze (or, as in France, in a special vessel), or else allowed to get hard on the blaze and then scraped off, as in the case of the spruce.

(2) Holes are bored into the part of the tree where the resin is formed or stored up, as in the heartwood in the case of larch.

(3) The resin ducts in the bark are opened, as is done in the case of the balsam fir.

Apart from the species of tree, the production of turpentine depends on—

(1) The dimensions of the tree, the production, *cæteris paribus,* increasing directly with the size.

(2) The situation; everything that is favourable to the growth of the tree, such as an open or sunny locality with an easterly or southerly aspect, increases the production of resin.

(3) The weather, particularly during the time of collection; prolonged heat and continuous rain are equally unfavourable, and a cold spring always prognosticates a poor harvest. The flows of resin increase from spring to autumn.

(4) The length of time the tapping lasts; during the first two or three years the yield is less than in those following. The Austrian pine appears to yield its maximum between the fourth and fifth year, or, in the case of very large trees, between the seventh and ninth year. This species in favourable localities can stand continuous tapping for 30 years, but it ceases to pay after six or eight years in the case of small stems, or ten to twelve years in the case of larger trees.

(5) The skill and care with which the tapping is done. As regards the age at which the tapping should be carried out, it has been shown that the best time is when the tree has reached its greatest height, and has, so to speak, arrived at maturity. The investigations of Fernow show that the maximum production of the long-leaf pine lies between the ages of 70 and 80 years. He is of opinion that the maximum is generally reached when the formula $\frac{d}{n}$ (diameter divided by the age in years) has its greatest value. With a view to the subsequent utilisation of the trees as timber, he fixes the minimum diameter at which tapping should commence at 14 inches, but the best size for both turpentine and timber production would be a diameter of from 18 to 20 inches.

In France, 14 inches, corresponding to an age of 30 years, is considered a reasonable minimum. In Austria, tapping begins when the trees are from 8 to 10 inches in diameter, or, in the case of the spruce, 12 inches. In the United States, on the other hand, every tree which appears likely to yield a profit to the extractor is ruthlessly tapped, under which course of ill-treatment the industry is digging its own grave.

Fernow draws attention to the relationship that exists between the formation of resin and the state of the foliage, and points out that a tree can only yield resin in abundance so long as it is in perfect health, especially in the case of species like the long-leaf pine, in which the resin is produced in the sapwood. These matters ought to be taken into consideration in regulating the width and

number of the blazes, while the facts that the resin ducts run vertically and that a long lead from the point where the resin exudes causes evaporation and consequent loss, indicate the desirability of making the blazes as short as possible.

Under the rational French system, the blazes are made 4 to 5 inches broad, with a depth of barely half an inch, and at the commencement are not more than 4 inches long. Under this treatment the tree can continue to yield resin throughout the term of its natural life. In Austria the trees are blazed over two-thirds of their circumference, and the length is at first only two inches. In the United States, "boxes" or reservoirs to catch the resin, are cut 10 to 12 inches deep in the tree, and the blazes are 12 to 14 inches wide, their number varying according to the size of the stem, no regard whatever being paid to the future well-being of the tree.

The American system, therefore, in no way fulfils the conditions of economical tapping, the Austrian system does so to a certain extent, but the French plan is the only rational one.

Frequent emptying of the resin reservoirs diminishes the loss of oil by evaporation. Scraping should be done only with the greatest care, and as there is practically no evaporation from the dried resin, it need not be often repeated.

The following is an exact description of the American method as described by Dr. Charles Mohr, Agent to the Division of Forestry.

In establishing a turpentine "orchard" and still, two considerations must be taken into account: first, suitable conditions, with regard to the export of the manufactured article and secondly, a sufficient supply of water for condensing. The copper stills commonly in use have a capacity of 800 gallons, which corresponds to a charge of from 600 to 750 gallons of crude resin. To keep a still of this size in continuous work during the season, filling it twice a day, not less than 4,000 acres of well-stocked pine forest are required. A block of this size is divided into 20 compartments, each with about 10,000 "boxes," or resin reservoirs cut into the tree. A compartment is termed a "crop," and is the unit allotted to each workman. The work begins in the early winter with the cutting out of the boxes. Until a few years ago, no trees were tapped under 12 inches in diameter, but recently, the workings have included trees as small as 8 inches. Two to four boxes are made in each tree according to size, so that 10,000 boxes require 4,000 to 5,000 trees, or about 200 acres of forest.

The boxes are cut 8 to 12 inches above the base of the tree, 6 to 7 inches high by 14 inches broad, slanting inwards at an angle of 35 degrees, and penetrating 7 inches into the tree. The reservoir is capable of holding about 3 pints.

To protect the boxes from danger of fire, the ground is cleared within a radius of three feet of the tree, and all inflammable material is heaped together and burnt. The burning of these heaps

destroys the surrounding young growth, and, unless care is taken, spreads to the neighbouring forest for miles round.

The flow of turpentine begins with the first days of spring and at the same time the "chipping" is begun, by which a blaze is made, 2 inches broad, 1 inch deep, and 10 inches high immediately above the box. The surface of this blaze is then chipped or hacked, for which purpose a special tool, called the "hacker" is used. This is a strong knife with a curved edge fastened to an iron handle, at the other end of which is an iron ball of about 4 lb. weight serving to give impetus to the blow.

When the flow begins to diminish, new cuts are made with the hacker, and this is repeated from March to October, often lasting over 32 weeks. The length of the blaze increases every month from $1\frac{1}{2}$ to 2 inches.

The accumulated resin is scooped out of the boxes with a ladle, and emptied into a cask for transport to the factory. During the first season the boxes are emptied seven times on an average, the 10,000 boxes yielding at each emptying about 1,200 gallons of "soft gum." The flow is most abundant during the hottest time of the year, in July and August, and gradually ceases with the setting in of the cooler weather, until in October or November it completely stops. When the resin begins to harden, it is scraped out of the box and blaze with a sharp scraper with a wooden handle. The result is scrape or "hard gum," which is of a dirty white colour, more or less mixed with foreign bodies, and only contains half as much oil as the soft gum. The first season gives a yield of about 8,400 gallons of liquid resin and about 2,100 gallons of hard resin which produce 2,000 to 2,100 gallons of spirits of turpentine and 260 barrels (of 80 gallons) of colophony of superior quality.

In the second year the boxes are emptied five or six times, yielding 6,750 gallons of soft gum and 3,600 gallons of hard resin, from which only about 1,900 gallons of spirits and 200 barrels of colophony are obtained. The resin becomes yearly darker in colour and less fluid. In the third and fourth years the boxes are only emptied three times, the yield in the third year, being 3,600 gallons of soft resin and 3,000 gallons of hard resin, from which is obtained 1,100 gallons of spirit and 100 barrels or more or less dark colophony. In the fourth year the yield of soft resin is somewhat less, and that of hard resin 3,000 gallons, producing 790 gallons of spirits and 100 barrels of colophony of the lowest quality. Tapping ceases as a rule after the fourth year.

It appears that the business of distilling requires great care and skill, in order to avoid overheating and loss of spirits, and to ensure that the product is of the best quality.

As soon as the still is heated somewhat above the melting point of the resin, a gentle stream of tepid water is allowed to flow into it from the condenser, and this is continued till the end of the

process, which is indicated by a peculiar noise arising in the boiling mass, and by the diminished yield of oil from the still. The temperature and amount of water admitted have to be regulated very carefully.

As soon as the distillation is completed, the fire is put out and the contents of the still drawn off through a stop-cock at its base. The melted colophony first passes through a wire sieve, and is then filtered through a coarse cotton cloth into a large trough whence it is poured into casks holding 280 lbs. each.

A turpentine distillery, working on a basis of 20 "crops," produces during the whole four years 120,000 gallons of spirits of turpentine, and nearly 12,000 barrels of colophony, or 2,800,000 lbs., worth approximately £12,000. The market price of the spirits of turpentine varies during the same season from a shilling and three halfpence to one-and-sevenpence farthing per gallon.

The average yield of a tree during the period of four years' tapping is from 1·2 to 1·5 gallons of spirits, and 3·75 gallons or 30lbs. of colophony of the better quality, worth altogether three shillings. The cost of extraction comes to two shillings and twopence-halfpenny, so that the net profit per tree per year is a little less than twopence-halfpenny, or from four to five shillings per acre.

It is calculated from the quantity of resin and spirit annually placed on the market that 2,250,000 acres of forest are in process of being tapped, and that 800,000 acres of virgin forest are every year brought into request, although at the commencement of the report Fernow estimates the latter at only 500,000 to 600,000 acres.

In the final article of the report Dr. Mohr discusses the turpentine industry, and draws attention to the improved method of distilling by steam as practised in New Orleans, which gives 30 per cent. more spirit than distillation over an open fire, without at all affecting the quality of the colophony.

He then describes the method of making turpentine from the wood of the long-leaf pine in an iron retort by means of superheated steam, by which otherwise worthless pieces and sawdust can be utilised. The process is as follows. The wood is cut up into short pieces, and wheeled on iron trucks into a steel retort 20 ft. long and 8 feet in diameter, capable of containing three cords, or 6,000 lbs. The doors are then hermetically closed, and superheated steam introduced, the retort being at the same time heated by means of a moderate fire. Distillation begins after six hours, at a temperature of 150° C.; during the next four hours the temperature is raised to 160° C., until no more liquid comes over. Steam is then shut off, and destructive distillation over an open fire is commenced. During the next 15 hours the temperature is raised to from 160° to 460° C., and the whole process lasts 24 hours. The residue is charcoal of good quality. A cord of wood yields from

5 to 18 gallons of spirits of turpentine and from 53 to 100 gallons of heavy oils and tar, known as creasote, or 60 gallons of strong acids with a specific gravity of 1·02, or 122 gallons of weaker acids. The gas is used for heating the still.

VI–EXTRACTS, NOTES & QUERIES.

The Grievances of the Forest Department.

The latest orders regarding the grant of extra pensions to Forest officers as conveyed in Secretary of State's Financial despatch No. 109, dated the 9th July, limit the concession to an extra pension of Rs. 1,000 *per annum* to officers who have render-*ed not less than three years'* approved service as Inspector-General, or as Conservator, 1st grade; that is to say, seven officers out of a total strength of 208 are rendered eligible for the extra pension. As the decision has caused a widespread feeling of discontent among all officers of the Department, and has given them reason to feel that they have not been fairly dealt with, and that the plain promises of the Secretary of State have not been fulfilled, we propose to give a short history of the case, and to state the grounds on which Forest officers are now so generally dissatisfied.

They claim to be placed on an equality, as regards their pension rules, with officers appointed from England to the Public Works Department during the same period. Now officers of the Public Works Department appointed previous to the receipt in India of the Secretary of State's despatch above quoted (*i. e.*, the 28th July 1896) are eligible for the pensions regulated by Articles 712 and 714 of the Civil Service Regulations. Under the latter Article special additional pensions over and above those allowed in

Article 712 may be granted as rewards of approved service in the high and responsible positions referred to below :—(*a*) Additional pensions of Rs. 2,000 per annum to those who have served three years as Chief Engineers, or officers who have been graded as such; (*b*) Additional pensions of Rs. 1,000 per annum to those who have served three years as Superintending Engineers. Under these rules 105 officers out of a total strength of 592 (this being the total number of officers on the Imperial staff in 1893), that is to say, 17·7 per cent. may become eligible for these extra pensions. Forest officers, therefore, who were appointed from England previous to 28th July 1896, claim that such of them as rise to high and responsible positions corresponding to that of Chief Engineer and Superintending Engineer, should be admitted to the same pensionary benefits as are enjoyed by their contemporary brother officers in the Public Works Department. The position of Inspector-General of Forests is as high and responsible a one as that of Chief Engineer, and the position of Conservator is as high and responsible as that of Superintending Engineer. Forest officers claim, therefore, that special additional pensions of Rs. 2,000 per annum ought to be granted to officers who have rendered not less than three years' service as Inspector-General of Forests, and an additional pension of Rs. 1,000 per annum to officers who have rendered not less than three years' approved service as Conservator of Forests. This concession, if granted, would render 20 appointments out of 208, *i. e.*, 9·6 per cent., eligible for additional pensions as against 17·7 per cent., as hitherto obtaining in the Public Works Department.

Now as to the causes which have led Forest officers appointed from England to consider that they are entitled as a matter of justice to be placed in all respects on an equality with their contemporary brother officers of the Public Works Department. The following are the main reasons which have led them to hold this opinion :—I. Officers of the Forest service are of the same social position and are trained at the same college as the officers of the Public Works Department. II. The Secretary of State in his *Financial despatch No. 310, dated 10th August 1876*, stated that the trained officers of the Forest Department occupied a closely analogous position to officers of the Public Works Department. III. From time to time various concessions made to the Public Works Department have also been extended to the Forest Department. IV. The Secretary of State has placed Forest officers appointed after 1893 on exactly the same footing as their contemporaries in the Public Works Department. If any difference exists between the services, therefore, it must have existed before and not after the 21st September 1893, because the Secretary of State in his despatch No. 188 of that date places officers thereafter entering either service on precisely the same footing. What change in the constitution of the services or in the claims or

responsibilities of these officers in the higher grades took place then or thereabouts? The services in India are ignorant of any. V. The Public Service Commission, specially appointed in 1889 to enquire into and report on the conditions of the different Departments in India, recommended, in the case of the Forest Department, that the conditions of service as to leave and pension should be assimilated to those of the Imperial Branch of the Public Works Department. VI. The Government of India fully approved of the recommendations made by the Public Service Commission, and has no less than five times under three different Governors-General, and with entirely differently constituted Councils, urged upon the Secretary of State the advisability of placing home-recruited officers of the Forest Department on an equality with similarly appointed officers of the Public Works Department; moreover, it was for the Forest Department alone out of the many departments whose claims were under consideration that this step was recommended. These are only a few of the many considerations which influence Forest officers and others in thinking that their claims have not been adequately recognised by the Secretary of State.

An additional reason why Forest officers feel that they have not been fairly dealt with is that for some considerable time they remained under the impression that their claims had been acceded to, and that the recommendations made by the Public Service Commission, which had been so many times urged by the Government of India, had actually been given effect to. Thus: Para. 17 *of the Official Regulations for the Forest Service Branch of the* Royal Engineering College, Coopers Hill for 1894 contained the statement: "The more favourable pension rules have recently been extended to Forest officers appointed from England, who are thus placed on an equality with Public Works officers appointed from Coopers Hill College." This statement undoubtedly deceived the service in India. "The more favourable pension rules" were notoriously those enjoyed at the time by Public Works and Telegraph officers. No favourable rules, the extension of which to Forest officers would produce "equality," exist other than *these contained in Chapter XXIX, Section III, of the Regulations*, including Articles 712 and 714. No other inference can possibly be drawn from the paragraph as it stands, than that Forest officers had been granted the same pensionary benefits as hitherto enjoyed by officers in the Public Works Department. For in it there is nothing whatever to show that only a portion of the more favourable rules, *viz.*, these under Article 712 had been extended to them, whilst those under Article 714 had been withheld.

Again, the Secretaty of State in his despatch No. 188, dated 21st September 1893, writes: "I sanction the extension of the scale of pension now granted *to the covenanted offices of the Public* Works and Telegraph Departments to officers appointed from England to the Forest Department." Again, the Secretary of State in the same despatch, and in his No. 230, dated December

26th, 1895, has stated that Forest officers who have rendered not less than three years' approved service as the Heads of the Department in any Province are *eligible for an additional pension of* Rs. 1,000 per annum. This statement he also made in Parliament in answer to a question put by Sir Richard Temple on the 31st July 1894. Conservators of Forests of all grades are *Heads of the Department* in their various Provinces. The duties and responsibilities of a Conservator of Forests are the same, be he of the 1st, 2nd or 3rd grade. The *most important Provinces may be held by* Conservators of any grade, and are, indeed, owing to the paucity of these *appointments not* often in the charge of a Conservator of the 1st grade. For example, the four Conservatorships in Burma, which are the most important in the service from a Revenue point of view, as well as perhaps the *most trying* physically, are at the present moment held as follows :—

Province.	Circle.	Rank of Conservator in charge.	Revenue *realized* during the year *1895-96.*
Lower Burma	Tenasserim	Offg. 3rd grade	17,76,000
Do.	Pegu	*3rd grade*	*16,39,000*
Upper Burma	Eastern	Offg. 3rd grade	15,75,000
Do.	Western	Do. do.	7,06,000

If Conservators of Forests of the 1st grade only are Heads of the Department, then in Burma, the most important of all Forest provinces, there is no Head of the Department at all. It *may* here be noted that it was not until the publication of Government of India Resolution. No. 2958 P., dated 22nd June 1895, in which the Inspector-General was alone *made eligible for an extra pension of* Rs. 1,000 a year, that any doubt was felt but that, as apparently promised by the Secretary of State both in Parliament and his despatches No. 188, dated 21st September 1893, and 230, *dated 26th* December 1895, and as publicly notified in para. 17 of the Coopers Hill Prospectus for 1894 and 1895, the benefits of Article 714 were to be extended to all trained Forest officers. Even then, the Department awaited with confidence the publication of the further orders regarding the Forest Department, *promised* in para. 2 of the Resolution above referred to. It was not until the publication of Government of India Resolution No. 3597 P., dated 21st August 1896, that the Department became aware that the extra *pensions* had been restricted to the Inspector-General of Forests and to Conservators of the 1st grade, of whom there are but six, out of the total controlling staff *(as it stood on the 1st January 1896) of 208 officers.*

Where, then, is the equality with officers of the Public Works *Department* which we have been told now exists? As a mater of fact, it exists only in the case of officers appointed *after the issue*

of the orders of 21st September 1893, while officers appointed before that date do not in any sense enjoy the some pensionary benefit as their contemporaries in the Public Works Department, as they had been led to believe they would do. And it is not to be wondered at that officers throughout the service are discontented at the way in which the Department has been treated by the Secretary of State, inasmuch as statements have been made in the Coopers Hill Prospectus, in his despatches, and in the House of Commons which have not been carried out. On what grounds can the Inspector-General of Forests and Conservators of Forests, 1st grade, be considered as the only Heads of Department? The Inspector-General of Forests is not a head of a Department at all, but is attached to the Government of India to assist it in the Forest business which comes before it. And if Conservators, 1st grade, are Heads of Department, as they are, so then are Conservators of the 2nd and 3rd grade also. A fact may here well be noticed which renders the refusal of the Secretary of State to extend the full benefits of Article 714 to the Forest Department, particularly galling, *viz.*, that under Article 704 natives of India of purely Asiatic descent appointed in India to the Public Works Department may become eligible for the full benefits of Article 714, which benefits have been but partially extended to Forest officers appointed and trained in England.

Owing to the unhealthy climate in which Forest officers are for the most part obliged to perform their duties, but few officers have any chance of earning the extra pension now sanctioned for Conservators of the 1st grade. This rank will be reached by but few officers, and in future hardly ever before an officer is 50 years of age, and the death rate prevailing amongst Forest officers is a high one. It may be noted that out of 22 trained officers posted to Bengal previous to 1895, the average length of service being at present 10 years, five, *i. e.* 22·72 per cent. have died, so that less than one-third are likely to reach 30 years' service. In Burma out of 37 officers, with an average service of 10½ years, seven, or 18·91 per cent. have died; so that the chances are that less than half the men appointed will reach 30 years' service. In Assam 20 per cent., with an average of 6¼ years' service have died. Taking all the Provinces of the Bengal Presidency together, out of 94 officers recruited up to the end of 1895, nineteen, *i. e.*, 20·22 per cent. have died, the average length of service being 12¾ years, at which rate only half the staff have a chance of reaching 30 years' service. These figures do not take into consideration causes other than death, such as early retirement on account of ill-health, &c., which have been numerous. The difficulty of obtaining a pension at all, let alone a special one, in the Forest Department, will be realized when it is noted that out of 128 officers who have left the Department, 56 have died, 28 resigned, frequently owing to ill-health, 12 retired on medical certificate and only 32, or 25 per

cent. obtained an ordinary pension. The cost of the concessions now asked for will not, it is believed, average more than Rs. 15,000, or at the existing rate of exchange, £891 per annum. In this connection attention may be called to the following figures showing the large increase which has taken place in the Forest revenue and surplus during the period 1873-74 to 1893-94, an increase which the officers to whom the India Office now denies the small pensionary concessions claimed, have succeeded in creating:—

	Revenue.	Expenditure.	Surplus.
1873-74 ...	66,62,565	41,88,387	24,74,178
1883-84 ...	1,08,54,882	67,06,890	41,47,992
1893-94 ...	1,77,13,020	93,40,700	83,72,230

It will doubtless be acknowledged that the Forest officers have a strong case, and that when their petition, signed by every trained officer on the Imperial Staff comes to be presented, as it will be shortly, to Parliament, they will be entitled to full consideration at the hands of that assembly.—*Englishman.*

The Formation of Sand Dunes.

At the meeting of the British Association at Liverpool, Mr. Vaughan Cornish contributed one of the most valuable and original papers read to the Section, in the form of a practical study of the formation and distribution of sand dunes. He said that in the sorting of materials by wind the coarser gravel is left on stony deserts or sea-beaches, the sand is heaped up in dune tracts, and the dust (consisting largely of friable materials which have been reduced to powder in the dune districts itself) forms widely-scattered deposits beyond the limits of the dune district. Three principal factors operate in dune tracts, *viz.*, (1) the wind, (2) the eddy in the lee of each obstacle, (3) gravity. The wind drifts the fine and the coarse sand. The upward motion of the eddy lifts the fine-sand, and, co-operating with the wind, sends it flying from the crest of the dune. The backward motion of the eddy arrests the forward drift of the coarser sand, and thus co-operates with the wind to build the permanent structure of the dune. Gravity reduces to the angle of rest any slopes which have been forced to a steeper pitch either by wind or eddy; hence in a group of dunes the amplitude cannot be greater than (about) one-third of the wave-length. This limit is most nearly approached, owing to an action which the author explained, when the wind blows alternately from opposite quarters. Gravity also acts upon the sand which flies from the crests, causing it to fall across the stream lines of the air. To the varying density of the sand-shower is due the varying angle of the windward slope of dunes. When there is no sand shower the windward becomes as steep as the leeward

slope. When the dune tract is all deep sand the lower part of the eddy gouges out the trough, and, when the sand-shower fails, the wind by drifting and the eddy by gouging, form isolated hills upon a hard bed. In a district of deep sand, negative dunes ("Suljes") may be formed. The encroachment of dune tract being due not only to the march of the dunes (by drifting), but also to the formation of new dunes to leeward from material supplied by the sand-shower, it follows that there is both a "group velocity" and a "wave velocity" of dunes. Since the wave velocity decreases as the amplitude increases, a sufficiently large dune is a stationary hill, even though composed of loose sand throughout. Where material is accumulated by the action of tidal currents, forms homologous with the ground plan of dunes are shown upon the charts. The vertical contours and the movements of subaqueous sand dunes are conditioned by the different tactics of sand-shower and sand-drift.—*Nature.*

Wealth based upon Elastic Gum.

The latest advices from Para, the greatest rubber mart at the mouth of the Amazon, are that more rubber has arrived there from the interior since July 1st, the beginning of the crop season, than in the same period of any preceding year. All records in rubber production in Brazil were broken in 1895, but it would not be surprising if the output should be still greater this season ; so that no fear need be entertained of a lack of rubber for bicycle tyres, or any of the thousand and one other modern uses for this wonderful gum. It is a singular fact that the yield of rubber from the Amazon valley has increased, almost without exception, in every year since 1839. All this time the work of exploring the tributaries of the Amazon has been going on, opening to navigation the world's greatest system of waterways, and, as every stream in that section is lined with rubber trees, naturally the gathering of gum has increased. There has also been developed a spirit of enterprise which gives promise of continued activity in the rubber trade. A dozen new steamers have been ordered within a year for navigating the Amazon and its branches, their principal purpose being to convey to market the ever-growing rubber crop, and to carry on their return an equal weight of merchandise obtained in exchange for it. Lately 1,300 miles of telegraph cable have been laid in the Amazon between Para, the seaport, and Manaos, the capital of the neighbouring State up the river, and its chier reliance of income is the rubber traffic.

Ninety-eight per cent. of the revenues of the State of Para come from the export duty on rubber, amounting to 21 per cent. of its value. At the present price of fine Para rubber the State collects 15 cents per pound as its share. With the development of

the rubber trade, the formerly insignificant village of Para has grown to be a city of 100,000 inhabitants, with several daily newspapers, eight banks, electric lights, street railways, which last year carried 10,000,000 passengers, the finest theatre in Brazil and beautiful parks, all the direct results of the trade in rubber. And Manaos, up the river, the rival of Para in the rubber trade, is undergoing a similar transformation, although the population is not yet so large. New York capitalists are now putting up an electric lighting plant in Manaos, and other modern improvements are gaining a foothold in this old Indian village which has become the capital of a State greater in extent than any in Uncle Sam's big family.

Thus it will be seen that rubber is the main stay and support of the Northern Brazilian States, both of the Governments and of the population, and the foundation of all municipal and commercial growth and of internal improvements of whatever character. The same thing is true of Bolivia and Eastern Peru, whose rubber output is floated down the Amazon to the seaboard, being credited in the end to Para. There would appear to be more reason for the veneration of the rubber tree by the natives of Brazil than by the Abors on the northern frontier of British India, according to whose mythology their rubber tree is the abode of a great and powerful spirit, whom they seek constantly to conciliate. But, while the people who regard the rubber tree as sacred will protect it at the risk of their lives, although it serves them no useful purpose, the Brazilian rubber gatherer has to be restrained by law from recklessly destroying the tree which yields his principal support.

But the countries named are by no means the only parts of the world that are being developed by the rubber traffic. The towns of Accra and Lagos, on the west coast of Africa, are attaining new importance from the same cause. The expected traffic in rubber is one great incentive to the building of the Congo railway, already half completed. The search for rubber is leading to the fuller exploration of Burma. Altogether, rubber is proving a great factor in civilization, being, besides ivory, the only commodity produced in the interior of any tropical country that will bear the expense of transportation to the seaboard. Thus it has been in many places the basis of the first commerce and the first transportation systems, opening the way to a diversified and more extensive traffic. Having served this useful purpose, the crude rubber, in the hands of the chemist and manufacturer, changes into forms which enter into every phase of life and have a bearing upon every branch of human endeavour. Without the rubber tyre, we should not have known the bicycle as it now exists, with its far reaching influence on health, manners and morals in every land, for it seems as if the bicycle would come into general use even in places where the wearing of clothes has never become popular. Yet, important as is the use of rubber for tyres, probably not more

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than 4 per cent. of the total consumption of rubber is handled in the bicycle trade. To master the details of its other uses would be equivalent to a liberal education.

The rubber of Brazil, gathered from trees which are native to no other countries, is so far superior that for many purposes other grades of rubber do not come into competition with it. It is in demand for tyres, for insulating electric wires, except for ocean cables, which are covered with gutta-percha, for waterproof clothing, the best rubber shoes, medical and surgical goods, erasers, etc., while the African and Asiatic rubbers are available for cheaper foot wear, door mats and some of the mechanical goods, such as hose, belting and packing for steam valves. Strange to say, English-speaking people have known this gum for more than a century as India rubber, although the most important supplies have always come from Brazil. The total output from British India from the beginning probably has not exceeded in weight the rubber now floated down the Amazon in a single year.

The following table of the world's productions of rubber for 1895, which has not been published, is compiled, to an important extent, from official sources. Where round numbers are used, they are based upon estimates believed to be too low rather than too high :—

	Pounds.
America.	
Mexico	160,802
Central America	2,000,000
Brazil	46,363,000
Other, South America	3,500,000
Africa.	
Gold Coast Colony	4,022,385
Lagos	5,060,504
Congo basin	1,406,543
Angola	4,000,000
Portuguese East Africa ...	*500,000*
German Africa	1,400,000
Madagascar	1,000,000
Other countries	2,500,000
Asia.	
Assam and Burma	1,000,000
East Indies	500,000
Total ...	73,413,234

As rubber has become more valuable, many chemists have attempted to produce artificial rubber, but without success as yet. But manufacturers have learned to extract rubber from worn-out

goods, so that every cast-off rubber shoe or bicycle tyre is now readily saleable for cash, for the manufacture of what is known as reclaimed rubber. Likewise the fear that the native forests might sometime become exhausted has led to numerous projects for the cultivation of rubber.

The British Government, alive always to the development of the resources of its colonies, becomes interested in the subject of establishing plantations of rubber in India, after certian experiments with rubber trees at the Royal Botanical Gardens had given promise of success. The first thing sought was to procure the best varieties from the Amazon valley, for which purpose a commission was given to Clements R. Markham, afterwards President of the Royal Geographical Society, whose success earlier in introducing the cultivation of Peruvian bark into Ceylon and India had revolutionised the production of quinine, and led to the abandonment of the cinchona forests in the Andes. Dr. Markham personally visited the South American rubber forests, and with the assistance of eminent British botanists, procured plants and seeds, under circumstances which added to the world's knowledge of rubber-bearing species and of the geography of Brazil. The result was less satisfactory than in the case of cinchona plantations, especially as the interest felt by the Government did not survive the long interval required for the Para rubber trees to become productive. There are now, however, in various parts of the Indian empire, groups of South American rubber trees, including 635 acres of 'plantations' on the island of Ceylon, from which a small first lot of gum was gathered last year for export. There has been a revival of interest in rubber in Ceylon, where, by the way, there are no indigenous rubber species of value, and many planters have been buying and planting Para rubber tree seeds, which are now included regularly in the price lists of the local nurserymen.

But the most important outcome of all these experiments is the Government plantation of the native rubber tree of India, established in 1873 at Charduar, near the Brahmaputra river, in Northern Assam, and a smaller one at Kulsi, in the same country. From a small beginning these plantations have been increased from time to time until they embrace two thousand acres. The trees first planted are now old enough for tapping, but as yet only a small amount of rubber has been produced, the first care being to produce vigorous trees. Among the many drawbacks to the maintenance of the plantations have been the ravages of wild elephants and deer, the one trampling down and the other feeding upon tender young trees, and also surreptitious tapping by natives more interested in a present pound of rubber than in the future welfare of the trees. The net result of the Indian experiments has been the demonstration that with little labor rubber trees may be grown from planted seeds, and that they will yield as well as native trees. But there are many ways of making money quicker, while the extent of the known rubber forests which remain untouched has

prevented most capitalists from giving serious attention to rubber cultivation.

In addition to the maintenance of the Charduar plantation, the Government of India has manifested its interest in rubber by extending its care of the forests in general to rubber in particular, by attempting the enforcement of regulations against cutting down the trees and against the collection of rubber by any method, excepting during certain months. As a feature of the system of regulation, licenses to gather rubber are sold by Government, and all persons other than the licensees are forbidden to go into the forests for rubber. Such regulations, of course, cannot be enforced among the tribesmen inhabiting the northern boundary of Assam, where the trees are gradually disappearing. But as the product credited to Assam thus shows a falling off, that of Burma increases through fresh discoveries of trees, so that, for a long term of years, the total product of rubber from British India as a whole, has scarcely varied one year from another.

Attempts at rubber cultivation on the Western Hemisphere have been more numerous, but more sporadic. Señor Don Matias Romers, who has been so long the Mexican Minister at Washington, wearying at one time of public life, retired to his native State of Chiapas and started an extensive plantation of rubber, but his vacation from office holding was brief, and the rubber trees planted by him did not thrive under the succeeding owner. More recently several plantations have come into existence as the result of a subsidy offered by the Mexican Government. The largest of these in the State of Oaxaca, contains 200,000 trees eight years old. An American engineer named Harriman settled in Tehuantepec several years ago and began experimenting with rubber trees for supplying the shade needed in the coffee plantations there, with such success that he has entered extensively into the growth of rubber and coffee together, this work having found imitators as far away as Ceylon. In Costa Rica, a Brooklyn man named Minor C. Keith, engaged in railroading, has won two large cash prizes offered by the Government to encourage rubber cultivation. In most of the Central American States steps have been taken by the Governments either to protect existing forests from the destruction with which they were once threatened, or to encourage the planting of more trees. The President of Nicaragua recently issued a decree prohibiting the gathering of rubber, save from plantations or privately owned lands, for ten years from January next. In Columbia some small plantations exist, and even in the Brazilian State of Para a law has been passed providing a reward of $546 (paper) for every 2,000 rubber trees planted. But all plantations growing out of these public measures are of too recent date for any important amount of rubber to have been produced from them.

A recent report from the British Foreign Office on rubber cultivation in Mexico estimates that the first year's yield from a

plantation of 100,000 trees will bring a net profit of $95,000, after deducting the entire cost of the land and all expenses up to the first year of harvesting, while each of the succeeding harvests for twenty-five or thirty years will bring a steady net income of over $100,000. The amount of land required would be 520 acres, and bananas and other crops could be grown between the trees for a few years, the possible profits from which are not taken into account in the above estimate. But people with money to invest are too apt to be deterred by the length of time required for a rubber plantation to be productive to take stock even in a concern promising such heavy profits, although oranges and many other fruits, coffee, tea, etc., do not yield cash returns much more promptly.

A more attractive prospectus can be gotten up for a company to "expoit" existing rubber forests. At this time an American syndicate is seeking capital to develop a concession covering 10,000,000 acres of lands in the Orinoco Valley, one expected source of profits being in the virgin rubber forests known to exist there. The subject of developing the Venezuelan rubber has at times engaged the attention of no less important personages than the Rothschilds, so that it will not be strange if less astute investors contribute funds toward this development. In London papers have been advertised lately the shares of a company with $1,000,000 capital, organized by a Frenchman, operating from New York, to gather rubber in a hitherto unexplored field in French Guiana. So it will be seen that opportunities exist in this trade for the promoter and speculator, as well as for the buyer and seller of rubber as a commodity. It has ever been so since the days of the London Caoutchouc Joint Stock Company, which proposed to extract rubber from the mulberry trees of Assam and apply it to silk spun from cocoons gathered from the same trees, using as a solvent for the gum the naphtha from neigbouring wells, the idea being to produce beautiful waterproof stuffs without leaving one's tracks as it were. There were great days, too, for the rubber promoter immediately following Charles Goodyear's inventions in rubber, when the increased demand for gum led to a rush of prospectors to the Amazon Valley, where they created a "boom" and were ruined by its collapse.

The United States having been from the beginning a larger consumer of rubber than any other country, the question of a home supply of the raw material has often been discussed. But not even during the period when there was a tariff on crude-rubber imports did any practical step towards rubber production take shape. There is, indeed, no reason to believe that the conditions of temperature, moisture, soil, &c., which exist in the home of the best rubber trees—say in the Amazon Valley or in India—are to be found anywhere in the United States. Where the Brazilian

rubber tree flourishes, orchids bloom in profusion in the open air, the climate being in effect, that of the interior of the hot houses in which our florists rear tropical plants. While there have been articles in the Florida newspapers of late about growing rubber trees, it is asserted by one of the best informed men in the trade in New York that there is no probability that such trees would flourish in that State any better than olive trees would on the metal roof of the Tombs prison. Wherever one of the many rubber species is indigenous, the tree may be grown as well from seeds planted by man as from those scattered by winds, and the product of one will be as rich in its quality of rubber as that of the other, but it requires something more than intense summer heat for brief periods to fit the United States for producing rubber.

HAWTHORNE HILL.

—*Scientific American Supplement.*

Wood-Paving in Rangoon.

A note written by Mr. Stirrat, Engineer to the Municipality says :—On 17th March 1896, the Public Works Sub-Committee recommended that a sum of Rs. 6,956 be expended on experiments with wood pavement. This recommendation was confirmed in general meeting held on 31st March 1896. A length of Merchant street, 120 feet, extending from Soolay Pagoda road to 32nd Street was selected to be laid the full breadth of road-way, or 50 feet, the total area being 6,000 square feet or 666 square yards. Two kinds of wood were selected, *viz*: teak and pyinkado, one half of the area being laid with samples of each kind. The blocks used were cut to equal sizes 6 inches long, by 3 inches broad by 6 inches deep, laid on a cement concrete foundation with the fibre vertical. The blocks were not creasoted or treated in any way before being laid but were grouted with tar, sand and gravel after being laid. Expansion joints are left at the sides of the road-way, along each length of channel about two inches in width, to provide for expansion and contraction. The pavement was laid in the rains, and was completed by the end of August 1896. A kerb and channel of brick and cement had to be laid on the south side of Merchant street, there being no footpath existing to bind in the blocks. The actual cost of laying this piece of wood pavement, exclusive of the cost of forming footpath kerb and channel on the south side of the street was Rs. 5,250-11-7, or about Rs. 0-14-0 per square foot, or about Rs. 7-14-0 per square yard. The cost of the blocks delivered were, for teak Rs. 50-0-0 per ton, and for pyinkado Rs. 42-0-0 per ton. It is thought that these prices, especially for teak, might be considerably reduced, should there be an increased demand for

these blocks. The number of teak blocks to a ton of 60 cubic feet is about 830; 742 of these blocks as laid in Merchant street occupy an area of about 100 square feet. To reduce the first cost of providing the foundation, which must be of a lasting and substantial nature, and not liable to subsidence, it is suggested that in laying any future pavement of this description, lime concrete might be tried. The estimated cost of the same area as already laid, if laid in lime concrete, would be about Rs. 4,125-0-0, or about Rs. 6-3-0 per square yard. To re-lay the road surface with blocks after the initial foundation has been originally put in, would cost about Rs. 4-9-0 per square yard, taking the blocks to cost the same per ton as for these already laid in Merchant street. Should the blocks be obtainable, as may be reasonably expected, for about Rs. 40 per ton for large quantities, the cost per square yard of renewing and re-laying would be about Rs. 4-2-0. The annual cost of maintenance and repair for macadam is about Re. 1 per 100 square feet per annum; with wood pavement it is believed that this annual charge would be much reduced.

It is of course as yet too early to give any definite report on the results of the wood pavement now laid, in regard to duration and any other qualities it may have over macadam. It will be seen, however, that the initial cost of laying it down and renewing it, is about double that of macadam, at present prices of stone metal. It remains to be seen whether the wood will be more lasting in respect of its other qualities of being a smoother and less noisy road-way. The life of macadam laid 6 inches deep on our main thoroughfares may be taken on an average at about from 4 to 5 years, so that the wood to be equal should last about 8 years before requiring entire renewal. Time only can show how far these qualities of wood pavement may extend. Meantime another length of wood pavement might be laid, on a lime concrete bed, say in Dalhousie street west of Soolay Pagoda road where the traffic is very heavy and where the tramway lines also pass thorough. From 32nd Street west to 31st Street would cost about Rs. 4,500, or even to Tsee Kai Maung Taulay Street would cost a total sum of Rs. 9,000 exclusive of the cost of re-laying the tram line which should be laid with continuous girder rails on a permanent concrete foundation throughout; as recommended in my report on the present tramway lines, the existing construction of the tram lines is not suitable for laying wood pavement satisfactorily.—*Rangoon Gazette.*

Woods Used by Cabinet Makers.

In a recent issue of *L' Echo Forestier*, appears a descriptive list of the various rare woods used in cabinet-making. It might be of interest to give the list entire.

Amboyna wood* is one of the most precious known. It has much the appearance of the choicest elm-knots,† though of greater delicacy. On account of its rarity, it is seldom used for furniture, though small coffers and clock-cases are made of it.

Close upon this follows black ebony, much of which is brought from Africa, though the most beautiful varieties come from the Island of Mauritius. Green ebony, of a dark olive-green color, is furnished by Madagascar. Portugal ebony,‡ from South America, is veined black and fawn color. Guiac wood,‖ of a greenish-brown, comes from America. Pomegranate wood, dark green, a native of Cochin China. Iron wood, dark brown, very dense and heavy, an American product. *Bois d'amourette*,§ from China, veined red and black, and much in demand. Agra, or perfumed wood, of a dark brown, also from China. The island service-tree,¶ dark brown, from Africa, Asia and America. Coral-wood,** of a beautiful red tint; and sandal-wood, in shades passing from dark red to pale yellow, all from India. Bamboo, in different shades, from different countries. Letter-wood,†† of variable red, from America. Partridge-wood,‡‡ gray-brown, from Martinique.

This list is sufficient to give an idea of the variety and richness of the darker woods used in cabinet-making. In regard to the lighter colored woods, a word may be said.

As mahogany§§ might be regarded as the type of the darker colored woods, maple might be taken as the type of those of a lighter color. The finest maple is from America. It is very difficult to work and requires skilled hands because the slightest

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* *Bois d'amboine*, from the island Amboyna of the Dutch Moluccas. Reported, though with doubt, as *Flindersia Amboinensis* Poir., of the natural order *Meliaceæ*, allied to the geranium family.

† *Loupe d'orme*; of elm knots, or excrescences, pretty knic-knacks and toys are often made, though they never grow large enough for the purposes of cabinet-makers.

‡ Portugal ebony is not a true ebony, but belongs to the natural order *Leguminosæ*, and is closely related to our native honey-locust *Gleditschia triacanthos)*. The true or black ebonies are of the natural order *Ebenanceæ*, and of the genus *Diospyros*, of which our native persimmon *(D. Virginiana)* is a species.

‖ Guiac-wood is from the tree *Guaiacum officinale*, L., a relative of the wofer ash *(Ptelea)* common along our more southern streams. The wood contains the resin known to medicine.

§ *Bois d' amourette*, a name, but awkardly translatable. It is from the tree *Acacia tennifolia*, Willd, belonging to the natural order *Leguminosæ*, and also a relative of the honey-locust and wild-sensitive plant.

¶ Service-tree; a tree nearly related to our mountain ash and choke-berry; *Pyrus aucuparia*, L., belonging to the natural order *Resaceæ*.

** Coral-wood is from the tree *Adenanthera pavonina*, also of the *Mimosa* division of the natural order *Leguminosæ*. Another name is pea-coral. Its seeds are said to be of such uniform weight that they are used in the East for estimating the weight of jewels.

†† *Bois de letters*; furnished by *Piratinera Guianensis*, Aubl., a tree of the elm-family, native in Guiana.

‡‡ *Bois de perdrix*; a species of Bocoa, of the natural order *Leguminosæ*.

§§ The author supposed his readers to be so well acquainted with it that he gave no description. *Swietena mahogani*, L., of the natural order *Meliaceæ*.

bungling makes irreparable blemishes on its fair, light surface. There is no recourse to mastic or patching, as in the case of darker woods. Like mahogany, maple occurs in many varieties.

Maple knots occur in varying depths of color. They are a very rare article, and are never employed in making anything but clock cases and fancy coffers. Silver maple knots are more frequently employed, though the wood is almost as rare.

The speckled maple is sometimes very white and dotted with fairly regular and close spots. It commands about the same price as ordinary mahogany, or about $4.00 per hundred weight (40 to 50 francs per quintal).

The gray, wavy maple (*l'erable ondule*) gives the beautful zig-zag effect of marble, and brings about the same price as the last.

Finally, the silver maple, a wood of great whiteness and taking a high polish. It is in great demand. In spite of its uniformity in coloring, it holds its place on the market on a par with the other varieties.

This last, as well as the speckled wood, is often used in the manufacture of entire pieces of furniture, while the other varieties are only used in veneering.

Citron-wood, * which is often wrongly called the wood of the citron tree, is also known as rose-wood, of the Antilles, and has no connection with the citron tree. The name citron-wood has been given it either by reason of its color, which is a pleasing yellow, or by reason of the faint aromatic odor it exhales while being worked. It is exquisite in grain and contrasts well with violet ebony. The so-called citron-wood furniture is justly much prized, but it is more suitable for mosaics and ornamental mouldings, or rose-work.

In conclusion, there might be named among the light colored woods the cedar, so highly esteemed by the ancients. Though it comes in many colors, the most frequent is the rose-veined. We might also mentien the white cinnamon, of Ceylon; the variegated white gum, of Guadeloupe; the gray laurel, of Mauritius; the West India rose-wood; the Jamaica balsam, and the tawny cypress, of Greece.

—*The Forester.* N. W.

Rudyard Kipling on the Indian Foresters.

Of the wheels of public service that turn under the Indian Government there is none more important than the Department of Woods and Forests. The reboisement of all India is in its hands

* *Bois de citron;* the French name for *Erithalis fruticosa*, of the order *Rubiaceæ*, and not to be confused with the product known in English by the same name, *i. e.*, *Callitris quadrivalvis*, a conifer of Africa yielding the gum resin sandarac.

or will be when Government has the money to spare. Its servants wrestle with wandering sand torrents and shifting dunes, wattling them at the sides, damming them in front, and pegging them down atop with coarse grass and unhappy pine after the rules of Nancy. They are responsible for all the timber in the State forests of the Himalayas, as well as for the denuded hillsides that the monsoons wash into dry gullies and aching ravines, each cut a mouth crying aloud what carelessness can do. They experiment with battalions of foreign trees, and coax the blue gum to take root and perhaps dry up the canal fever. In the plains the chief part of their duty is to see that the belt fire-lines in the forest reserves are kept clean, so that when drought comes and the cattle starve, they may throw the reserve open to the villagers' herds and allow the man himself to gather sticks. They poll and lop for the stacked railway fuel along the lines that burn no coal, they calculate the profit of their plantations to five points of decimals, they are the doctors and midwives of the huge teak forests of Upper Burmah, the rubber of the Eastern jungles, and they are always hampered by lack of funds. But since a Forest officer's business takes him far from the beaten track and the regular stations, he learns to grow wise in more than wood-lore alone, to know the people and the polity of the jungle, meeting tiger, leopard, bear, wild dog, and all the deer, not once or twice after days of beating, but again and again in the execution of his duty. He spends much time in saddle or under canvas, the friend of newly planted trees, the associate of uncouth rangers and hairy trackers, till the woods that show his care in turn set their mark upon him, and he ceases to sing the naughty French songs he learned at Nancy, and grows silent with the silent things of the undergrowth.—*Kipling in McClure's Magazine.*

A Spider that Eats Birds.

If asked to name the thing I most dreaded when in the tropical forests on the Savannas, says a writer in the *New Orleans Times-Democrat*, I think it would be the centipede. Scorpions are bad enough; some species of ants are extremely troublesome; various minute insects, like the "bete rouge" or red bug, the chigoe or "jigger," and the "garrapata" or wood-tick, are things to be avoided; but the centipede is by far the worst of them all. It has not, as its name would indicate, a hundred feet, but it has between thirty and forty, each one poisonous. And once let a centipede get on your skin and become alarmed, no power on earth can remove it quickly enough to prevent it from digging its venomous claws into your flesh. It moves with the celerity of "greased lightning," and when seen running across an open floor

appears like a brown streak. There is one other object more horrible to contemplate, and that is the tarantula, which also moves with surprising quickness. It does not glide, however, like a thing of evil, as the centipede does; but leaps direct at one with a viciousness not to be mistaken. I remember well my first attempt to capture one, in the beautiful botanical garden of Martinique, in the West Indies. I was strolling along the avenue of stately palms (since destroyed by a hurricane), when I saw a big tarantula directly in the path before me, half-hidden beneath the dead leaf of a bread-fruit tree. I had a stick in my hand, and poked the spider to make it get into the open. Instead of turning about to escape, it made a leap for my hand, which it missed only by a few inches. That was enough for me; I did not crave a live tarantula for my collection, though a moment later there was a dead spider in the path. Even in death it is an ugly appearing thing, large and hairy, with legs that would stretch across a saucer. On another occasion I saw a tarantula on the wall of a hut by the roadside, right over the doorway, through which the occupants of the hut, a black woman and her children, were constantly passing. I called their attention to the creature, but they merely glanced at it carelessly, and allowed it to retreat into the thatch of the roof.

There is, however, one spider larger than the common tarantula, which is abundant enough to be an object of dread in the forests of the Guianas. This is the great Bird Spider, the *Mygale avicularia*, which catches and kills not only birds, but lizards, other small reptiles, and even young chickens. It builds its nest in the trees, and there lies in wait, just as the house spider does for flies, leaping upon its victim like a tiger. It is, in fact, the tiger of the tribe, and is justly feared by both birds and human beings. In my excursions into the woods I used to pass an old tree, the trunk of which was slightly hollowed. Beneath the overhanging bark above the hollow a family of bats had affixed themselves, six of them, hanging by their toes, noses downward. They always clung in the form of a triangle, three bats in the upper row, then a row of two, a single bat at the bottom. One day I missed the lowermost one, but the next day his place had been supplied. The following day two were gone; and when I inquired of my negro guide the reason and manner of his taking off, he informed me that probably a bird spider had captured him. At another time I was hunting along the shore for small birds, among the sea-grapes, the hanging racemes of creamy white flowers attracting birds and insects, owing to the honey which they contained. The first bird I shot there was a black and yellow "sugar-eater," so called from its liking for sugar and all sweet things, a frequent visitor to the sugar plantations during the boiling season. It fell, as I fired, into a dense cluster of sea-grapes; another bird attracted my attention just then, and first noting the location of the one I had shot, I went in pursuit of the second. I soon returned, but

could not find my bird, though I knew he must be somewhere near. As I was peering through the leaves, however, a slight rustling drew my attention to a very comical sight. It was a large lizard, which, with one foot placed upon the bird I had shot, was intently watching me with his diamond-bright eyes. He had stripped off some of the feathers from the dead bird, which he was hastily devouring, having first drawn it some distance from the spot where it had fallen. A tuft of yellow feathers stuck to his nose, and those he vainly endeavoured to scratch off with the claws of his right forefoot, at the same time eyeing me very suspiciously. First he would make a dig at his nose, then cock his head over to one side with a malicious gleam in his eyes, as if to ask what I was going to do about it. The whole proceeding seems to me so entertaining that, as there were sugar-eaters in plenty, I was ready to leave Mr. Lizard in possession and go off in search of another bird. But suddenly, just as I was turning away, a black, hairy object fell upon the lizard ; there was a short, sharp struggle, and my predatory friend was still in death. I was much disgusted at the terminations of the adventure. I might easily have killed the spider (for such it was), but I did not ; I left him to enjoy his double dinner of bird and lizard. It was indeed a revolting spectacle to see that horrible thing descend upon its victim. Its bite or sting is said to be extremely poisonous, and I concluded that this must be so from the expeditious manner in which it caused the death of the unlucky little reptile, itself as long as its slayer. The incident made me decidedly nervous. The hideous-looking, but harmless iguanas have a habit of darting noisily through and over the dead leaves on the ground ; and for a long time, at every rush I would leap hastily aside, under the impression that it was one of those huge and venomous spiders.

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The "Restoration" of Mountains.

The *Révue des Eaux et Forêts* has an article from the pen of M. Charles Broilliard on the subject of the fixation and consolidation of the French Alps to put an end to the disastrous inundations and torrents which devastate the low-lying country. One is inclined to think of "restoration" of mountains as synonymous with "reboisment," but, although reboisment is the aim, there is yet a long stage to be passed through before we can arrive at this, and in many places it is necessary to be content with a mere clothing of the hillsides with grass. In France they passed a law in 1860 under which the Forest Department was given very large powers for dealing with this matter, but the law of 1882 cut these powers down very considerably. The Department is now obliged to pay for all ground it takes up as "perimeters of reboisment," or, if it does not actually buy out proprietary rights, but merely takes over the land to deal with, it can only take it over for ten years and must pay a rent for it. However, M. Broilliard finds a means of effecting the purpose amied at—at any rate to a considerable extent—in article 5 of the existing law, which allows the grant of "Subventions" to persons taking upon themselves works of improvement of the kind required. M. Broilliard shews that there is practically no hope of effectually dealing with the Alps by direct artificial reboisment, considering the enormous area concerned, but he thinks that with the help of this article 5 of the law, the aim may be attained nevertheless. His suggestion simply is that the State should pay communes and owners of mountain waste lands (and it would seem that the country in question is practically entirely the property of communes and private proprietors) a subvention in return for substituting cattle-grazing for sheep and goat-grazing on the areas in question. The fact is that in addition to the actual grazing of cattle being less obnoxious than that of sheep and goats, it also cannot extend to the steeper slopes, which are the prime cause of the mischief,

and whence especially torrents and inundations have their source, and this will allow of grass and eventually trees establishing themselves. Up to date the State has only been able to take in hand some five per cent. of the total area affected, and at this rate the work would seem to be hopeless. Moreover, the hopelessness is not merely one of length of time, but of means also; the figure to be paid would be one that imagination "boggles" at. It is therefore absolutely necessary to find some means of a general and far-reaching kind (like fire conservancy in India), which will allow nature herself to act; and this measure, as stated above, is to be found in the substitution of the cow for the goat and sheep. But M. Broilliard contends, not only that this is possible under the existing law, but also that it will be most advantageous to the owners themselves. Though this gain may not be seen by them at once, it will very soon be made clear to them after an object-lesson or two; and when the measure has been extended to a few communes all should gradually come to see things in their true light. The gain consists in the fact that the introduction of "fruitières"—cheese manufacturies in the mountains, where the cattle are housed on the premises, and graze on the Alpine herbage—has very greatly enriched the promoters and local inhabitants engaged in the business, and M. Broilliard quotes statistics to show how great this improvement has been in the countries where "fruitières" have taken root. Moreover, the number of sheep and goats has already very much diminished in these parts, under the indirect influence of "fruitières."

On the general question of the stability of mountains, it seems to me that people are apt to forget that when the hill is itself shattered through geological causes, as is the case with a great part of the Himalayas, no tree-growth can really prevent slipping, the origin of the evil being far below the roots, although it will, no doubt, prevent the water rushing off in torrential form and launching itself with accumulated force on the country below. But while there is this advantage, there is yet another risk due to this very *prevention of rapid running off* of water, namely, that the water has time to sink in, and the weight on the hillside then becomes enormous. It was said to be due to saturation of this kind that the great slip of 1880 occurred at Naini Tal. This danger would affect the valley immediately below, while the fields at the base of the mountain range would, of course, always benefit by a retarded flow of water from above.

Then, too, it is necessary to find the best form of forest to grow on a hillside. A great deal might be written on this subject, but as a first suggestion, I would point out that trees of large growth are apt to be swayed by the wind, and therefore to loosen the soil at their roots, and it would consequently seem advisable to adopt as thick a growth of simple coppice as possible.

MILES.

For little-known Trees—a Correction.

The article on little-known trees in our December number contains an error, the timber therein referred to as *Eriolæna Candollei* being the wood of *Cordia Macleodii.* The particular log on which our remarks were based is one which was sent to Mr. Gleadow, some time ago, as *E. Candollei*, and he, after trying it for various uses, only thought of comparing it with the Forest School specimens after sending us the information, the log he used having come from a source usually quite reliable.

Eriolæna Candollei is itself a good timber which might well have found a place in our article, but, its appropriate uses differ from those of *Cordia Macleodii.* The former is a tough wood of a brick-red colour possessing considerable elasticity and strength; the annual rings are distinct. It is an excellent timber for shafts and such purposes. *Cordia Macleodii*, on the other hand, is a wood of no great strength, but easy to work, of sufficient hardness, and of some beauty.

IV.—REVIEWS.

Les Landes et les Dunes de Gascogne.*

One day in August 1893, leaving the pretty villas of Arcachon with their surrounding luxuriant vegetation of pines, evergreen oaks, exotic conifers, palms and a profusion of flowering climbers, I rode with Monsieur Grandjean, the writer of this valuable little book, for 30 miles through the woods of Maritime or Cluster Pine, which surmount a dense undergrowth of oaks, arbutus, tree-heather and gorse, on the sandy soil of the *Forêt de la Teste*. We saw the resin-tappers at their work, the young pines which had sprung up from natural seed blown from neighbouring trees on to the areas where the 60-years old pines had been tapped to death and removed, the long bare lines of the fire-traces (so necessary to isolate burning blocks of the inflammable pine forest and to assist in extinguishing a fire), the wind-swept, crooked and distorted pines on the protection-belt near the sea, where thirty-years old trees are frequently only 4 feet high, and finally, the littoral dune, stretching like a railway embankment as far as the eye can reach, North or South, along the Bay of Biscay.

The motto of the town of Arcachon, founded as a bathing place in 1828, and now visited annually by 200,000 people, is, *Heri solitudo, hodie vicus, cras civitas*: in truth the region of the Landes, swampy in winter, an arid desert in summer, dangerously malarious, where 2½ acres barely supported a sheep, and the lonely shepherds on their stilts were almost the only inhabitants, where villages and towns and Bordeaux itself, the third city of France, were threatened by the steady invasion of the sand—this desolate region has now been drained and its salubrity restored; since 1857, 1,625,000 acres have been planted with pines, roads constructed, houses built, fields of wheat, maize, rye, and meadows interspersed among the woods, whilst the population of some of the parishes have sextupled during the present century.

A hundred years ago, land was so cheap in the sandy tracts of Gascony that a purchaser might climb a sand-hill and obtain for £1 a tract as far as he could make his voice heard—now, the yield of resin and turpentine from the extensive Gascon pine forests is only second to that of the United States (where resining trees is practised in a most wasteful manner and cannot be expected to last many years more), and thousands of tons of pit timber leave Bordeaux annually for the Welsh coal mines.

Grandjean gives an interesting account of the geology of the region, with its rows of sandy hills parallel to the coast, which

* By C. Grandjean, Inspecteur-adjoint des Forêts; with 10 plates, pp. 92. Paris: J. Rothschild, 13 Rue des Saints Pères.

up to the end of last century were continually invading the more fertile country to the East, the impermeable strata termed *alios*, which helped to form the swamps, the lagoons which appear to be land-locked inlets cut off from the sea by sand-bars, the water having lost its saltness by filtering through the sand. Gascony at the end of last century was an immense desert of shifting sand, the drainage water was driven back landwards, forests and villages were buried, or about to be buried in sand.

A separate chapter is devoted to the history of the fixing of these shifting sand-dunes, and from this it appears that, (omitting a reference to the former unsuccessful attempts to solve the problem) in 1769, and again in 1776, the Abbé Désbiez and his brother read papers to the Academy of Bordeaux on proposed methods of arresting these destructive sands. It appears that, in 1779, some attempts were made by de Ruat and Désbiez to protect their own *estates by planting trees*, but these plantations were destroyed by sheep. The trees said to have been used by Désbiez were planes and poplars, which will thrive only where there is sufficient permanent moisture in the soil, certainly not in the arid sand where only pines can grow.

In 1776, Louis XVI, by the advice of Neckar, sent the Baron of Charlevoix-Villers, a naval engineer from St. Domingo, to report on the establishment of a naval port at Arcachon, and the latter, after thoroughly examining the region, submitted several reports, in which he mentions the names of all who had made previous suggestions towards fixing the sand, and recommended that the first step to be taken should be to sow pines, the very means which were afterwards successfully adopted. De Villers met with much hostility from high local officials who were jealous of his influence at Court, and, suffering badly from malarial fever, he was unable to carry out his well devised plans; he therefore returned to St. Domingo in 1784.

Brémontier, an assistant State engineer at Bordeaux, was then taken up by the local authorities, who handed him the reports and papers of de Villers and Désbiez; of these he made full use, but entirely ignored them in his own writings. Being, however, a clever, active man and thoroughly believing in the future success of his plans, he obtained, in 1788, an annual credit of £180, and commenced operations near Arcachon, sowing up and fixing 900 acres of sandy dune by 1793. His work was, however, interrupted by the revolutionary troubles till 1800, when the First Consul allotted £2,000 a year for it and this amount was gradually increased up to £16,000 in 1854.

Statues have been raised to Brémontier and streets named after Desbiez, both in Bordeaux and Arcachon, but no notice was taken of de Villers, the originator of the successful scheme for fixing the sand, till 1890 when M. Dulignon-Desgranges read a paper before the Academy of Bordeaux, which justly assigned the share each of these three men had taken in the enterprise. Up to the

present time, at the expense of the State, 157,800 acres of sand-dunes have been fixed and planted with pines, 54,800 acres of *lèdes* (low lands between the dunes) have been drained and handed, over to the villages for cultivation or pasture, 7,500 acres bordering on the ocean are kept as protective forest, while future invasions of sand are guarded against by over 125 miles of littoral dune, which is carefully maintained in good condition.

Grandjean considers that the chief danger which now threatens Arcachon is from the reduction of the area of its basin, owing to the cultivation of oysters, which at present occupies an area of 10,000 acres, and supports 20,000 people, producing annually 300,000,000 oysters. The consequent reduction in depth of the basin is driving the sea against Arcachon, and very costly works are neccessary to protect the town and its beach effectually.

A chapter on the littoral dune explains in full detail its mode of construction and maintenance, and Grandjean modestly relates how he has been able to reduce the cost of the latter by means of marram grass (*Psamma arenaria*), as by planting it thickly, sand may be made to accumulate in depressions, while by cutting away any excess of marram from the surface of the dune, all superfluous sand is removed by the wind.

France may be justly proud of this conquest over the wild forces of nature, the works to secure which are now visited by many foreign engineers and foresters. M. Grandjean promises to publish shortly a further work on the legislation of the dunes and the management of the maritime pine forests and the works for draining and improving the Landes.

CLAREMONT, EGHAM,
November 9th, 1896.

W. R. FISHER.

The Durabilty of Railway Sleepers.

We are indebted to the Inspector-General of Forests for a copy of the statement showing to the end of the year 1895, *renewals of* wooden sleepers on State railways as ascertained from experimental sleepers registered in accordance with the Government of India Circular No. 12 Railway, dated the 3rd November 1880.

Turning first to the completed experiments we find the following results recorded :—

Railway.	Description of Timber.	No. of Sleepers experimented with.	Average age at time of renewal. Years.
Rajputana-Malwa	Creosoted Pine ...	217	5
	Sal ...	83	17
	Kahoo (*Terminalia Arjuna*)	13	4
Eastern Bengal N. Section	Creosoted Pine ...	1,755	8
	Sal ...	52	11
	Red Gum ...	9	9

The following table shows the state, at the end of 1895, of the principal experiments, commenced prior to 1887.

Year laid down	Railway	Description of Timber	No of Sleepers laid down	Average age of unsound sleepers removed years	Sound sleepers remaining	
					No.	Percentage of total laid down
1876	Rajputana—Malwa	Deodar ..	2054	13	1923	93
		Creosoted Pine ..	6585	11	1392	21
		Teak ..	689	14	193	27
		Terminalia Arjuna ..	1986	15	262	13
		Hardwickia binata ..	902	14	225	24
1877	Eastern Bengal ..	Sal ..	1970	13	700	35
	North Western ..	Deodar ..	1416	16	1152	81
1878	North Western ..	Creosoted Pine ..	382	14	185	48
1879	Eastern Bengal ..	Sal ..	2006	10	1429	71
1880	Rajputana-Malwa ..	Creosoted Pine ..	13524	9	50	0·4
	S. Mahratta	Creosoted Pine ..	718	10	435	61
		Teak ..	139	9	129	93
1881	S. Mahratta	Creosoted Pine ..	589	9	322	55
		Teak ..	1020	7	931	91
1882	Rajputana-Malwa	Deodar ..	1166	9	381	33
		Creosoted Pine ..	89	..	89	100
	North-Western ..	Deodar ..	600	..	600	100
1883	S. Mahratta	Teak ..	96	..	96	100
		Creosoted Pine ..	604	5	531	88
	North-Western ..	Deodar ..	200	11	53	26
	Eastern Bengal	Sal ..	899	7	480	53
		Pyinkado ..	106	12	79	74
1884	Rajputana-Malwa ..	Deodar ..	11943	9	11647	97
	S Mahratta ..	Creosoted Pine ..	114	6	93	81
	Eastern Bengal	Sal ..	678	9	650	95
		Pyinkado ..	1823	7	1668	91
	Rajpura-Bhàtinda ..	Deodar ..	200	11	158	79
1885	Eastern Bengal	Sal ..	1166	8	1029	88
		Pyinkado ..	1745	8	1720	98
	North-Western ..	Deodar ..	1000	12	964	96
1886	S. Mahratta ..	Pyinkado ..	2000	9	1981	99
	Eastern Bengal	Sal ..	553	7	523	94
		Pyinkado ..	821	..	821	100
	Rohilkund-Kumaon	Sal ..	1486	7	1476	99
		Terminalia tomentosa ..	496	7	285	57

Some of the figures appear rather suspicious. It will be noticed, for instance, that 90 per cent. of the deodar sleepers laid down on the Rajputana-Malwa Railway in 1876 are still sound, whereas of those laid down in 1882 only 33 per cent. have survived, the presumption is that in the latter case a number of pine sleepers were passed off as deodar. The same has been known to happen in regard to pyinkado, sleepers of inferior hard woods dyed with cutch, being substituted for the real article.

From the older experiments it seems clear that in Northern India, deodar easily takes the first place in regard to durability, that teak comes next to it, and that both teak and sal last longer than creosoted pine. It would not, however, be safe to draw general conclusions from the statistics given in the table, as apart from the amount of traffic that passes over them, sleepers of the same kind of wood vary greatly in durability according to the climate of the tract in which are used.

It is a pity that no figures are given for the Burma State Railway, where pyinkado has been principally used since the line was first opened, but we believe it has been found that the latter wood is very much more lasting as a sleeper than teak.

VI—EXTRACTS, NOTES & QUERIES.

Wanted Vols. I and XI of the "Indian Forester" for Coopers Hill.

Vols. I and XI of the *Indian Forester* are required to complete the set in the Library at Coopers Hill Engineering College. It is hoped that any one willing to present, or sell their volumes, will communicate with W. R. Fisher, Claremont, Egham, Surrey.

The Reorganization of the Subordinate Forest Service.

A despatch from the Secretary of State announces that the scheme for reorganising the subordinate service in the Indian Forest Department has been sanctioned. We have frequently pointed out the urgent need for this scheme, which will cost about 1¾ lakhs annually, but will result in a permanent gain to the State. It will take three years to work out the changes, which involve a reduction in the number of subordinates temporarily employed.—*Pioneer*.

Chicago Exhibition Awards.

We have received from the Inspector-General of Forests the following list of medals and diplomas awarded to the Forest Department of India in connection with the Chicago Exhibition of 1893.

Details of items for which diplomas were awarded :—

(1) "For illustrating by means of well-drawn maps the distribution of forest areas in different districts of British India and showing also the means of protection against forest fire."

(2) "For an instructive exhibit of the woods of Assam, of great value in international commerce."

(3) "For showing in a highly instructive manner the different stages of development from the crude to the manufactured article in resins and oils."

(4) "For a display of sawed Padouk lumber, the product of the Andaman Islands, well adapted for purposes of ornamental construction."

With one medal marked "Revenue and Agricultural Department."

(5) "For interesting presentation, in series, of the commercial and indigenous fibres of India, with their common and scientific names."

(6) "For excellence of a comprehensive collection of seeds from which oil is produced."

(7) "*For* the educational value of a collection of oils from plants growing in India, thus showing the resources of the country in oleaginous plants."	With a medal *marked* "Conservator of Forests."
(8) "For a good collection of the minor forest products of the North-Western Provinces of India." (9) "For an exhibit of the valuable timber of the *Central Provinces* of India, among which teak-wood and satinwood may be mentioned as most important for international commerce."	With one medal marked "Conser*vator* of Forests."

In adition to the above awards the Forest Departments in Madras and Bombay have each received a medal and diploma: while a medal and diploma have been awarded to Mistri Harnam Singh, of Chandeli in the Hoshiarpur District, Punjab, for the carved mantelpiece *described on page* 13 of the Chicago Exhibition Handbook, and to Maung Shwe Daing, of Mandalay, for the carved doorway of teakwood specified on page 32 of the Handbook. Two medals *have also* been awarded to the Inspector-General of Forests in connection with diplomas (5) and (6).

The 9 diplomas and 3 medals have been sent to the Dehra Dun Forest School, where they will be suitably mounted and deposited in the Museum.

The Scarcity of Teak.

Mr. Keith Anstruther writes to the *Globe*:—Referring to your recent article on the "Scarcity of Teak," I would say that there is no reckless exhaustion of the forests allowed by the Government of Siam, and *we all know that our own Government*, is conserving most strictly the teak interests in Burma. Present trade information denotes only a slight improvement upon recent prices, and the quotations themselves show that the trade cannot afford to pay prices that would justify greater deliveries. Unless the demand were equal to the supply, prices would revert to their *old figures*. The Siamese Government is by no means indifferent in the matter of conserving their forests and replenishing them, and *it has at the present moment one of the most* able of our own Forest officers advising on all matters connected with the Forest Department. It is shown by the present forest leases, that the

Siamese Government is fully aware of the value of their property in the north, and are doing their utmost to conserve it. Having up to the present time represented in the Northern States of Siam the only purely Forest company in the Lao States, I say distinctly that the Siamese Government is now controlling the work in the forests, so that there is no fear of de-forestation, and the only question is whether the trade can afford to pay the prices that will be remunerative to foresters, for the expenses connected with the business are so great that the returns at the present time can scarcely afford margin of profit.

Gutta Percha.

The Foreign Office has recently issued a Report by Consul Churchill on the Balata industry of the colony of Netherlands Guiana, which is of interest to Forest officers in India, as it shows that the list of trees which yield gutta-percha or indiarubber is by no means complete.

Balata is a kind of gutta-percha obtained from the milky juice of the bark of the bully or bullet-tree, *Mimusops Balata*, a large forest tree belonging to the order *Sapotaceæ*, which ranges from Jamaica and Trinidad to Venezuela and French Guiana. Although the tree has been known for years past, and its wood, which is very hard, largely used for sugar-mill rollers, machinery and building purposes, the collection of the juice for the manufacture of gutta-percha is of quite recent origin, and it is to this point that we wish to draw attention, as there are probably a number of trees indigenous to India which are capable of yielding gutta-percha in paying quantities. The matter is worth the attention of Forest officers, especially of them in charge of evergreen forests in the Southern Provinces. In connection with this, we would invite a reference to a letter from Mr. Lushington printed in this month's issue, and to the genera mentioned by him would add *Isonandra*, which also belongs to the order *Sapolaceæ*.

We reproduce below some extracts from the report in question :—

'The bullet-tree is found (in Netherlands Guiana) in greater abundance in the low-lying zone of fluvio-marine deposit. It is also found in the higher lands of the interior, but in a less abundant and more scattered condition. On the bullet-tree bearing grounds in forests, where they are plentiful, the observer may see from 20 to 30 trees of a thickness of 12 to 30 inches within a radius of 100 feet around him, where this tree is less plentiful, the observer will only see two or three trees within the same area. The bleeder usually looks over his head and discovers the tree by its foliage. He also knows that the bullet-tree must be near when

he comes upon certain kinds of bush. Above a trunk thickness of about 30 inches the tree is usually not worth bleeding.'

'The tree often grows in zones or belts, on which it prevails in excess of all other trees. The limits of these zones or belts being crossed, the forest may be traversed for hours without a single bullet-tree being met with, after which perhaps another zone is run into.'

'Regarding the character of balata, Mr. Jenman quotes Dr. Hugo Müller, F. R. S., as follows :'—

"Although my own opinion about balata, derived from personal experience, of its practical application in a few instances was entirely favourable, I thought it desirable to avail myself of an opportunity of obtaining a further opinion direct from an india-rubber manufacturer, considering that this would be much more to your purpose than anything I could say on my own account, hence the delay in my answering your letter."

"It seems, then, that balata is by no means neglected, and, in fact, it would find ready purchasers if more of it came to the market. As it is, the supply is very limited, and generally it comes only once a year. It commands a higher price than gutta-percha, and this in itself is a proof of its usefulness. It is used almost in all cases in which gutta-percha is used, but on account of its higher price only for superior purposes."

"It seems that balata is treated by the manufacturers simply as a superior kind of gutta-percha, and, therefore, its name disappears when manufactured."

"*Nevertheless, balata is distinctly different from gutta*-percha, and this is especially manifested in some of its physical characters, for instance, it is somewhat softer at ordinary temperature, and not so rigid in the cold."

"The chemical composition, however, is probably quite identical with that of gutta-percha and of caoutchouc."

"In one respect balata shows a very marked and important difference from gutta-percha, and that is in its behaviour under the influence of the atmosphere, whilst gutta-perch when exposed to light and air soon becomes altered on the surface and changed *into a brittle resinous substance, into which the whole of the mass* is gradually converted, in the course of time balata, on the other hand, is but slowly acted upon under the circumstances."

"I inclose a piece of balata tissue which has now been in my possession quite six years, and although it shows a peculiar mealy efflorescence, due to chemical change, it is still supple and coherent. A similar tissue of gutta-percha would have long before now become entirely converted into a brittle resin."

"The electrical insulating quality of balata is said to be quite equal to that of gutta-percha, and altogether there seems to be no question about the valuable properties of balata. *All that is wanted* is a sufficient and constant supply, and a somewhat lower price. But

even at its present price, I think, it would find a ready market if it came in large quantities, and thus enabled manufacturers to use it for applications on a large scale. As far as I could make out, it is used by itself and not mixed with gutta-percha."

'The balata industry of this colony is in its infancy. In Surinam the forests which have been bled are abandoned, and new lands are sought for and exploited up to date. Only those areas where an abundance of trees is to be found have been selected. On areas where 100 trees are found it sometimes happens that about 75 per cent. only give milk at the particular period when the bleeder visits them, and that at some later period the remaining trees will also run; but as the bleeders have gone beyond that particular section, it is not profitable to come back and bleed the remaining trees just at the special time when they are ripe for it.'

'The forests are all the property of the Crown, and are leased by the Colonial Government at a rental of 10c. (1d.) per hectare per annum for the exploitation of balata only, and that in conformity with the Balata Ordinance of the colony.'

'There is no export duty whatever.'

'The bleeder receives advances from his employers against which he contracts to deliver balata. For his balata he receives from 50 to 55c. (10d. to 11d.) per lb., delivered on the concession. An average bleeder will gather about four gallons per day A very successful bleeder may get as much as 10 gallons during the same period. In Surinam a bleeder will gather an average of 1 gallon per tree, bleeding from the base of the tree up to a height of 20 feet and scarifying the back to half its circumference only, further scarification being illegal. A gallon of milk will dry to about 4 lbs. of balata."

'The bleeders are mostly recruited from Berbice, in British Guiana, and about 1,000 men are at present employed in this colony in the industry.'

'The hot and very wet seasons are not good for balata bleeding. The trees blossom in August, and the seed drops about the *month of November, when the new leaf shoots out. By the end of* January the milk obtains the condition when it runs most plentifully. The leaves of the old trees, the milk of which is not easily getatable, are dark-brown on the lower side and green above, the younger trees are light green on both sides. During the flowering season the milk does not flow to any paying extent. The leaves of the young trees are thick, and, when broken, the milk issues freely from the wounds. After the month of August to the middle of January no work is done, this leaves about eight working months.'

'Balata cannot be purchased in the market in Paramaribo. It is only gathered for those who employ balata bleeders, therefore, no quotation as to its price can be given, although it will be seen from the statistics of the exportation of this commodity, which the Colonial Government have very kindly placed at my disposal, that for statistical purposes a valuation is given. The only certain

thing that is known is, that the bleeder receives from some employers 50 and from others 55c. per 1 lb. for the balata which he produces on the concession. Beyond this, however, there are other expenses which must be added, such as commissions to foremen, loss by runaway bleeders, deaths, thefts, loss by capsizing of boats, cost of transportation, surveying of concessions on occasions of dispute as to boundaries, assistance of pilots, Indian trackers, &c.'

'*Return of Balata extracted from the Colony of Netherlands Guiana.*'

Year.	Quantity Kilos.	Value Florins.
1889	1,509	1,509
1890	76,326	95,407
1891	95,587	143,381
1892	120,680	181,019
1893	32,546	65,092
1894	108,286	216,573
1895	133,681	267,362

Amber.

Amber, once among the most prized of natural ornaments, is again coming into fashion. Its praises are sung by the author of the "Tears of the Heliades,"* in prose which gives a correct and not unduly enthusiastic account of the history of the substance in fancy and fashion. In a coloured plate of a necklace of Sicilian amber, with tints not only of yellow and orange but of iridescent greens, blues, and greys, he shows that some rare form of amber may really take the place of a "gem" when properly polished and set. Its beauty in a more concrete form may be seen in several of the leading jewellers' shops, where trinkets of the loveliest clouded yellow amber—cigarette-cases, powder-boxes, and other small and costly articles of minor jewellery—are set with turquoise, diamonds, rubies, and sapphires in bands of small stones, as evidence of the place in luxury which the amber may fill. It is difficult to understand why its beauties have been forgotten. It appealed to the æsthetic sense no less than to the imagination of the most primitive, and the most "decadent" of mortals, from the British chief who purchased it from traders over the sea, and had it buried in his tomb, to Nero, whose fleet brought back from the "Amber Shore" thirteen thousand pounds' weight for his enjoyment, and who in his ode to Poppæa likened his wife's hair

* *Tears of the Heliades: Amber as a Gem.* By W. A. Buffum, London; Sampson, Low and Co,

to its golden tints. There is a wide range in the tints of amber, and the Roman ladies who dyed their tresses in imitation may have taken any shade from ripe apricot to lemon colour. But in some aspect or another, fashion, fancy, religion, or medicine, amber has never failed to attract the West until recent days, when an imperfect imitation of Oriental feeling has devoted it mainly to the service of smoke. Its intrinsic merits are due at least as much to the sense of touch as of sight. It is exquisitely light, and of a warm smoothness like no other substance. Its electric properties heighten the feeling that this is no stone, but the organic substance nearest to the chilly sovereignty of the gem, and superior to the gem because, as Thales of Miletus said, "it has life." So Pytheas, seeking the Amber Shore, found Britain, and on the coast of Courland, and from the Helder to the Elbe, the amber fishery, and later, amber mining, have lasted from the founding of Olbia until to-day. And Pliny knew, though he did not express it scientifically, that amber has the same specific gravity as sea-water, and travels with the current when the storms break up the submarine substances. "It rolls along, and seems to hang in the water."

It is in the nature of a miracle that the amber forests have perished, or only survive as shapeless masses of carbon, while the balsam distilled from their branches remains perfect, in golden drops and honey-icicles. "Nothing but the straw and scum floats down the river of time," said the philosophers; "solid things perish or sink on the way." But the amber, though Pytheas said it was the scum of the "encrusted sea," is the essence of those perished forests, overflowing life-drops from the giant trees. The coal and lignite are mere organic evidence of the past. "Here," we say, "is coal,--here, then, was a prehistoric forest." It leaves on us no sense of a present in the past, few striking records of the shapes or forms of the dead world, not the faintest relic of an episode, not one vision of the play of life in those rolling ages of which it is the mute memorial. But the amber-drops that are the lively records of the life of this dead world. In their transparent depths are enclosed the minute evidences of the days of the ancient amber-land, instantaneous photographs of incidents in the life of insects, of leaves and seeds, of events so insignificant as to weigh but as dust in the balance in the course of the world as it was, but strangely interesting to us looking back from the world as it is. Stories of forest-life beneath these trees are present in the amber, of incidents as slight that we have as little right to expect their preservation as that of the wind in their branches,—moments of time measured by the falling of a drop, or by the beating of an insect's wing. Contrast this irreducible time-minimum of event with the immensity of the duration of the record of that event, and the attraction of the amber inclosures to the imagination may be in part explained. It is not only, as Bacon says, that "the

Spider, Flye, and Ant, being tender dissipable substances, falling into Amber, are therein buryed, finding therein both a Death, and Tombe, preserving them better from corruption than a Royall Monument;" we also see the manner of their death, the nature of the falling amber, whether fluid, like water, or viscous, like honey, and the fly, extending its wings and making an instinctive movement to fly as the drop engulfed it. We judge the season of the year from the freshness or decay of the inclosed leaves, or the feathers shed by a moulting bird. It is not enough that the fossil-resin has preserved the seeds, the cone-scales and the tiniest leaflets of the forest; it has inclosed the insects which fed upon the leaves, and the spiders and the webs of the spiders which fed upon the insects. Thus, in the collection of *inclusa* at South Kensington, a clear drop of dark, honey-coloured amber, incloses an insect on a tiny lanceolate-leaf. It resembles the cricket-like creatures found in long grass, the favourite prey of ground-spiders. The cricket was sitting on the leaf,—uttering, no doubt, a thankful chirrup before he began his breakfast, when the amber rain descended; and there, like unhappy Ajax, *sedet, æternumque sedebit*, life-like though entomben, a cricket, perhaps ten thousand years old, nourished on leaves of which that inclosed with him is the sole survivor of what were once as thick as those in Vallombrosa. Next the cricket lies another of the midgets of the amber forest,—a tiny fly. It spread its wings as the drop fell and before it could make the down stroke of propulsion the liquid hardened and preserved it,—dead, but a "living picture" of the miocene fly in action. The fly has for neighbour a spider, overwhelmed by the same fate; and, by a happy contrast of comparison of the ancient and the modern world, beside these venerable flies and spiders, amber-endowed with everlasting youth, are insects inclosed in the amber of to-day. It is not amber, but copal; shed not on the shores of the Baltic, but on the coast of Zanzibar. But it is amber in the making, not differing in appearance from the fossil gum; clear and pale like frozen honey; hard to the touch as amber. Yet it must have dropped from the trees like water, stiffening on the instant that it fell. For in the copal block is not one, or two, but a whole procession of imprisoned insects,—dead it would seem, while engaged in some social duty. Perhaps it is merely a procession, but it looks like a locust funeral, or the *déménagement* of an ant colony, in two lines, going and returning. Were they enclosed in Sicilian amber their value would be priceless in a Palermo shop, for the scene resembles exactly that universal "house-moving" of the poorer Italian families seen before Easter. It is a *sgomderaménto* in amber. There were thirty kinds of pine in the amber forest, and we know this and guess the proportion of this or that to the other trees by the fragments found in the fossil sap which has survived its parent forest. The most common of all was a "Tree of Life," which has left five times as many fragments preserved in the amber

as has any other pine. But oaks and willows, beeches, poplar, birch and alder, and even a camphor tree, all flourished in the wood together, by the unimpeachable testimony of the amber museum. So, too, the entomologists and others have found a little preserve in what is known as the amber fauna. "Among the spiders is the remarkable genus *Archæa*, which differs from the living species by the position of the eyes, by the extraordinarily large jaws, and by the head, which is very distinctly separated from the breast. Some of the insects unite in themselves characteristics of several families or orders now living, and present a form out of which in the later development of the animal world, two different forms proceeded. A feather proves that the amber forest contained birds, but of mammalia nothing has been found but a tuft of hair. Fishes and amphibious animals are also wanting. Frogs, lizards, and fishes are shown in amber, but they have been introduced by artificial means. Bubbles of air, and even drops of water, occur, and in Berendt's collection there was a spider, in the translucent body of which the movable air-bubble could be seen to shift its place at every turn given to the place."

The magic properties ascribed to amber were the natural result of its electric power. Yet this belief does not account for the wearing of a cube of amber by the Shahs of Persia as a protection against assassination, nor for its use as material for poison-detecting cups. In the former case the cube was said to have fallen from heaven ; in the latter its organic origin was thought to disclose the presence of mineral poisons, and its colour to change when vegetable drugs were present in the wine. Nor has the magic of amber any relation to Meinhold's striking tale of "The Amber Witch." The poor girl discovered a surface amber mine, and was able to make money enough to buy comforts for her father's house and to give to the poor of his parish. This was enough to rouse the suspicions of the horrible age when envy had always ready the terrible engine of the witchcraft trial. Those who can endure the perusal of these records of malignity may read them in "common form" in the pages of "The Amber Witch."
—*Spectator*.

India Rubber.

Mr. H. Kingsley writes as follows to the Editor of the *Spectator* : Sir,—I have read, as I am sure many West-Coasters will have read, with great interest your article in the *Spectator* of November 14th on indiarubber, and I should much like to ask the learned writer thereof if something might not be done to reinstate the rubber-vines in those West African districts where the wasteful way

in which the natives have collected it has stamped the trade out, and whether this reinstating might not be effected by the judicious felling of timber at a slight expense, because, if done judiciously, the timber felled would be of value and help to pay expenses. From what I have seen of the rich rubber districts of Western Africa, the stamping out of rubber in a district arises primarily from the native pulling down every rubber-vine he sees and cutting it up into small pieces with a view to putting those pieces round a fire and running the rubber into a calabash ; or, when the vines are too strong for him to do this, making murderous wounds on them with his machete ; secondarily, it arises from the very trying habits of the *Landolphia* in insisting on starting life from a seed—it will not send out side branches if its top is cut off, and it will not send up shoots from its roots. Now in dense African forests the chances of seeds are few and far between. They fall upon the ground 150 ft. or 200 ft. below the region whereon the sunshine and the rain plays. You may go for months through the great Forest Belt of Africa in a grim twilight gloom, seeing nothing day out and day in but countless thousands of bare grey tree-stems festooned with great bush-ropes twined and twisted round each other and round the tree-columns, as bare of foliage as a ship's wire rigging, and looking like some Homeric battle of serpents arrested at its height by a magic spell. If your way takes you on to a mountain-top and you look down on the country you have traversed you can hardly recognise it in the wild, luxuriant mass of beauty, redolent in colour and perfume, that stretches before you, the top of the forest ; but if you keep on the level ground you will come now and again to an oasis of new life where one of the forest giants having grown above his fellows and so given the tornado a grip on him, has been destroyed. He has been cast by the tornado wind a wreck to rot, or turned in a second from a glorious living thing into a seared skeleton by the tornado's lightnings. If you will carefully examine such an oasis of new life, caused by the sunlight and rain reaching the ground instead of the top of the forest, you will see thousands of young plants coming up, and among the medley you will, I think I may say, always see young rubber-vines. A very few of these vines will ultimately survive ; only those, in fact, which by their wonderful hook-tackle arrangements have gripped on to the two or three saplings of great forest trees which are destined to win in the race for life with their neighbours, and take the place of the great fallen monarch tree and those round him which have been wrecked by his fall. Of course, to carry out clearings in West African forests means the institution of a Forestry Department like that of India, and this for trade purposes is not immediately required ; for the quantity of rubber in West Africa is enormous. The *Kicksia*, the Lagos rubber-tree that has been brought so profitably forward by Sir Alfred Maloney and Sir Gilbert Carter of

Lagos, is by no means confined to Lagos. It grows in great luxuriance all along the South-West Coast; but at present the African does not know it is a rubber-tree down there, and confines his attention to the vines, to *Landolphia Owariensis*, from which he gets the high quality rubber; to *Landolphia florida* from which he gets flake rubber; and to five other bush-ropes, from which he gets a sap which is not true rubber at all, but which he uses, with many other things, to adulterate his rubber with, to the end of making it heavier, because it is bought of him by weight, and it is his nature to adulterate everything that passes through his hands. A Forestry Department is, however, a great need in those portions of the West African Coast that fringe the Western Soudan, like the Gold, Ivory, and Slave Coasts. The forests here are only fringing forests between the Sea of Sand, the Sahara and the Salt Sea, or the Bight of Benin, and are in danger of being *destroyed by the native, in his terribly destructive way of making* his farm,—clearing a patch of bush, cultivating it for a season, then letting it go into a worthless jungle; and clearing another patch. Such disforested regions you will find round Acra and the Elmina Plain; and in those regions of this disforested land most remote from the Forest it is almost impossible now for the native to make a plantation whose yield is sufficient for his needs, because the destruction of the forests diminishes the rainfall,—for example the rainfall at Acra is about forty-five inches per annum, and this is not sufficient to support a luxurious food-producing vegetation in a tropical district subjected to a long dry season and the intensely drying action of the wind from the Sahara, and if the destruction of the forests is allowed to go on at its present rate for a few more years, we shall find ourselves facing famine in West Africa. The South-West Coast, which commences at Cameroon, is under different climatic conditions. Cameroons, with its volcanic island series of Fernando Po, San Thomé, and Principe, has an infinitely richer soil and a heavy and evenly distributed rainfall; below Cameroons you are in the region of double seasons, two wet and two dry, until you reach Congo; and in this double-season region the growth of vegetation is so rapid that the native has to fight back the forest as a Dutchman fights the sea, and moreover the mass of the South-West Coast natives are not so much dependent on plantations as those of the West Coast, for they are nomadic hunters. I see you notice the German efforts to improve the producing power of Cameroons, and I should like to add that the French Government in Congo Française are equally active, and among other things have encouraged the planting of the para-rubber tree, which flourishes exceedingly.

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Coppice with Standards in the Vosges.

An Example.

The October and November Numbers of the *Revue des Eaux et Forêts* contain articles on the above subject from the pen of M. Henri Watier, who has been making careful experiments on the cover of the standards, and who will be remembered as a keen forester and a good comrade by those who were at Nancy some twenty years ago. Although the oak and beech referred to do not exist in India, *there are other trees* to which M. Watier's ideas and methods may be applied, and I therefore reproduce the principal points of the articles in question.

Not only in the Lower Vosges, but also over a great part of France, and in other countries, too, the conditions of forest supply are changing. Formerly, the standards produced a certain amount of timber which was mostly used up locally, while the firewood was necessary in large quantities to maintain numbers of local factories, foundries, glass-works, &c. But the tendency of modern commerce has been to extinguish these small industries in favour of a few very large concerns using coal. At the same time, the improvement and increase of sawmills, and the immense development of the railway network, make it possible, and, indeed, necessary, to transport the forest produce to those places where the density of the population demands it. The result is, that the *importance of the standards has greatly increased, while that of the coppice has diminished.* Why not, then, convert to the seedling régime? The answer is, that in some cases it is impossible, or inadvisable, in others, the necessity for a more or less difficult and doubtful experiment is not distinctly proven. In fact, the simplicity and order of the coppice method are not to be lightly abandoned, especially as the trade appears still to prefer moderate sized goods to handle, in the case in point. *The problem thus is, how to preserve the advantages of the coppice method, while producing the greatest possible number of standards.* Several solutions have been proposed, mostly based on the cover of the

standards. The "balivage normal" of M. Burel may be selected as the type of these. It depends upon exact calculations of the area strictly necessary in order that the coppice may produce the number of likely stems required for the annual reservation, neither more nor less. The method is a purely speculative one involving numerous experiments on the cover and increment of the trees and endless calculations. M. Watier has marked one or two coupes according to this system, but the result remains to be seen.

Naturally, the present discussion only refers to forests on soil capable of producing a considerable amount of large timber.

The forests in which M. Watier's experiments were made are those of Aingeville, Bulgneville, Mandres-sur-Vair, Vaudoncourt, and Parey-Saint-Ouen, situate about 12 miles from Neufchateau. The principal work was done in the three first mentioned, which were chosen especially on account of the proportion of oak standards they contain. Aingeville is pure oak; Bulgneville has 75 per cent. oak with 25 per cent. beech, while Mandres has half and half.

Aingeville.—Coupe No. 4 is a forest of the plains, of 4 hectares 35 ares, containing coppice 29 and 30 years old, growing on the Gryphæa limestone. Its production is estimated at 15 stères of billets and 700 faggots, or 40 cubic metres per hectare. The reserve is consituted as follows :—

I. Class. 368 (34 per hectare)	222 Oaks 2 Beech *156 Various*
II. Class 314 (72 per hectare)	310 Oaks of 0·88 girth 1 Beech 2 Hornbeam 1 Aspen
III. Class 40 (9 per hectare)	20 Oaks of 1·25 girth 13 of 1·50 4 of 1 75 3 of 2 00

Exclusive of the I. Class, the yield amounts to—

II. Class 217 *m. c.* }
III. Class 110 *m. c.* } 317 *m. c.* or 75 *m. c.* per hectare.

The reserves abandoned contain—

146	Oaks and	8	Various,	of 0·50 girth
81	,,	,, 6	,,	,, 0·75
68	,,	,, ,,	,,	,, 1·00
29	,,	,, 1	Beech	,, 1·25
9	,,	,, ,,	,,	,, 1·50
9	,,	,, ,,	,	,, 1 75
2	,,	,, ,,	,,	,, 2 00
344		15	Various	

The volume of which, bole and crown, amounts to 230 *m. c.*, of which 324 *m. c.* is oak, or 53 *m. c.* per hectare.

The coupe thus contains just before the felling a total volume of—

128 *m. c.* per hectare in Classes II. and III.
5 „ „ „ Class I
45 „ „ „ Coppice

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Bulgneville.—Coupe No. 12, of 5, *H*, 59, *A*., aged 25 years, (that being the rotation here), situate on a lower lias sandstone plateau, an excellent forest soil, estimated at 15 stéres of billets and 600 faggots, or 40 *m. c.*, per hectare. The constitution of the reserve need not be given here. It is given in tabular form lower down, where, however, the "various" are classed as oaks, for the reasons there stated The details above given for Aingeville will suffice for those who may attempt similar work in this country.

The volume of the reserve is :—

II.	Class, Oak and Ash	123 *m. c.*	156 *m. c.*
	Beech and Various	33 *m. c.*	
III.	Class, Oak and Ash	213 *m. c.*	275 *m. c.*
	Beech	62 *m. c.*	
			431 *m. c.*

or 77 *m. c.* per hectare.

The trees abandoned comprise 196 oak and ash, 69 beech, and 15 various. These 280 trees yield—

Oak and Ash	253 *m. c.*	351 *m. c.* or 63 *m. c.* per hectare.
Beech and Various	98 *m. c.*	

The coupe thus contains, just prior to the felling—

140 *m. c.* in Classes II and III.
40 *m. c.* in Coppice
5 *m. c.* in Class I.

185 *m. c.*

Mandrés.—Coupe No. 10, same situation and soil, 5, *H*, 94, *A*, aged 35 and 36 years, estimated to produce 10 stéres of billets and 600 faggots, or 37 *m. c.* per hectare. The reserve comprises oak, beech, and others, I Class 585, II Class 372, III Class 95, with a volume, excluding class I, of 589 *m. c.*, or 99 *m. c.* per hectare. The trees abandoned are 492, with a volume of 667 *m. c.*, or 109 *m. c.* per hectare.

The coupe thus contains, just prior to the felling—

208 *m. c.* per hectare in Classes II and III
37 in Coppice
5 in Class I.

250 *m. c.*

The cover of the Standards.—It was taught by Messrs. Lorenz and Parade, that on good soils, just before the felling, the standards ought never to cover more than one-third of the surface. The propriety of this principle has been contested, by Messrs. Puton and Bartet among others. The three selected coupes abovementioned, *being on good soil, it becomes interesting to* see what is the cover of the reserves in them. By cover is meant the area of the horizontal projection of the crown. In practice, this is taken as the area of the circle described round the mean diameter of the horizontal projection. This mean diameter is found with sufficient exactitude by taking two diameters at right angles to one another. Accordingly M. Watier measured these two diameters for each tree in the three coupes referred to, which may be called "*exploitable coupes.*" But, rightly suspecting important differences, he was induced to make similar measurements in the preceding ones which *had been felled over and contained a two-year old* regrowth. These coupes may be called '*exploited coupes.*" The trees were classed by species and size as follows: in the *exploitable coupe,* a mean girth was found for the trees of Class II (or of two rotations); the reserves of Class III and upwards were divided into groups at intervals of 0·25 beginning with a girth of 1·25 and the abandoned trees into groups at intervals of 0·25 beginning at 0·50. The reason for separating the trees abandoned from those reserved is, that it is a rule, in marking a coupe, that whenever there is a choice between two trees of the same size, the one with the better developed crown is reserved and the other abandoned. In the *exploited coupe* the trees were divided into groups at intervals of 0·25, beginning at 0·50 girth. The number of trees measured was 1,312 oaks, 408 beech, and 40 various. These last, being so few, have been classed as oaks without introducing any appreciable error.

The following are the results of measurement in the exploitable coupes :—

AINGEVILLE.

Classes and number.				Diameter D of the crown.	Cover $\frac{3\cdot14}{4}$	Cover per Class.	Cover of the trees reserved.	Cover of the trees abandoned.	Total Cover.
				Metres.	Sq. m.	Ares	Ares.	Ares.	Ares.
314	Oaks	Class II		3·6	10	31·14			
20	,,	of	1·25	6·0	28	5·60			
13	,,	,,	1·50	6·3	33	4·29	45·47 or 10 %		
4	,,	,,	1·75	3·0	64	2·56			
3	,,	,,	2·00	9·2	66	1·98			78·78 or 18%
154	Trees	,,	0·50	2·0	3	4·62			
87	,,	,,	0·75	3·0	7	6·09			
68	,,	,,	1·00	4·1	13	8·84			
30	,,	,,	1·25	5·1	20	6·00	...	33·31 or 8%	
9	,,	,,	1·50	6·4	32	2·88			
9	,,	,,	1·75	7·3	42	3·78			
2	,,	,,	2·00	8·4	55	1·10			

It would take up too much space to give the detailed figures for Bulgneville and Mandres; suffice it to say that in the former the reserves cover 80·82 ares, or 14%, the trees abandoned cover 54·47 ares, or 10%, and the total cover is 1 hect. 35·29 ares. In Mandres, the reserves cover 1 hect. 29·58 ares, or 22%, the trees abandoned cover 1 hect. 06·24 ares, or 23%, and the total is 2 hect. 64 82 ares, always exclusive of the 1st class, or trees of the age of the coppice. Thus, the 128 *m. c.* of Aingeville cover 18 ares, the 140 *m. c.* of Bulgneville cover 24 ares, and the 208 *m. c.* of Mandres cover 45 ares. The disproportion between the volumes and the areas is due to the composition; at Aingeville there is a large number of small oaks half smothered in the coppice, while at Mandres there are more large trees, including beech, which have the mastery over the coppice. The point is this, that the maximum cover found was 45 ares for 208 *m. c.*, whereas M. Bartet, in his investigations, found that volumes of 80 to 90 *m. c.* covered 61 to 63 ares. The discrepancy requires explanation, and can only be due to the fact that M. Bartet must have measured his cover in exploited coupes, instead of in exploitable ones. It thus becomes of interest to see what would be the cover of the reserves, had it been measured *after*, instead of *before* the felling. This is shown in the following table :—

AINGEVILLE.

Classes and number.	Diameter D of the Crown.	Cover $\frac{3 \cdot 14}{4}$	Cover per Class.	Cover of the trees reserved.	Cover of the trees abandoned.	Total Cover.
	metres.	sq. m.	h. a.	h. a.	h. a.	h. a.
314 Oaks II Class	7·4	43	1·35·02			
20 Oaks of 1·25	9 0	64	12 80			
13 ,, 1·50	10 3	83	10·79	1·66·52		
4 ,, 1·75	11 5	104	4·16	or 38%		
3 ,, 2·00	12·6	125	3·75			
154 Trees of 050	4·6	17	26 8			
87 ,, 0·75	6·5	33	28 71			2·83·65
68 ,, 1·00	8·3	54	36·72			or 65%
30 ,, 1·25	9 0	64	19·20		1·30·14	
9 ,, 1·50	10·3	83	7·47		—13·01*	
9 ,, 1·75	11·5	104	9 36		1·17·13	
2 ,, 2·00	12 6	115	2·50		or 27%	

Bulgneville and Mandres are similarly treated. In the former, the figures work out as follows: cover of the reserves, 1 hect. 72·87 ares or 31% cover of the trees abandoned, 1 hect. 18·96

* The same units of cover having been applied alike to the reserved and to the trees abandoned, a deduction of 10 per cent. is made from the latter, as was done by M. Bartet.

ares, or 21 %, total 2 hect. 91·83, or 52 %. In Mandres, the cover of the reserves works out to 2 hect. 00·08, or 34 per cent., the cover of the trees abandoned to 1 hect. 91·22, or 32 per cent., total 3 hect. 91·30, or 66 per cent.

The results thus differ widely for trees of the same girth, according as their cover is measured just before or soon after a felling. Thus, per hectare:—

At Aingeville,	18 ares *before*,	65 ares *after* the felling	
Bulgneville,	24 ,,	52 ,, ,,	,,
Mandres,	45 ,,	66 ,, ,,	,,

from which it may be concluded—

I. That the cover of standards varies widely according as it is measured before or after a felling;

II. That there is a great expansion of the crowns immediately after a felling;*

III. That this expansion is much greater in a young crop than in an old one;

IV. That in the exploitable coupe the dictum of Messrs. Lorenz and Parade is not far out, and they themselves laid it down as an approximation only.

The Coppice Rotation.—When the circumstances, soil, &c., permit, the rotation should always be a long one, 30 years or more. Doubtless, a short rotation isolates the standards more often, and they take on a sudden increment each time, but the benefit of this is neutralised by the injury to the coppice, and by other disadvantages. Until the age of 18 years the coppice furnishes little more than brushwood, of little value, while after this age the brushwood begins to turn into billets, having a much higher market-value. Evidently, at 30 years old, the proportion of billets will be very considerable, and in the Vosges, the value of billets is about double that of brushwood per *m. c.* As an instance may be cited the coupes of Vrécourt in 1891-94, which sold for 1,600-2,000 fr. per hectare, while the 20-year old coupes of the locality brought in less than half. With a rotation of 30 years, the first class stems reserved for the first time are strong enough to resist atmospheric influences, which is absolutely necessary if an intensive culture is aimed at. Short rotations frequently provide a pitiable spectacle of young stems unable to bear the weight of their own crowns. A long rotation alone can furnish boles long enough for all uses, many otherwise fine logs selling for a small price because of their shortness. The coppice also suffers less from the cover to the standards under a long rotation than under a short one, since a crown of given area does far less harm when it is high up than when it is low down.

The increment of the standards.—In 1886-87, with a view to carrying out the "balivage normal" of M. Burel, M. Watier took the trouble to measure the size, the height, and the cover, of some

* This, with its accompanying increase in volume, is a fact having a certain bearing on the "Thinnings" controversy,—vide Nov. No., pp. 433-5.

4000 standards. He duly carried out the Burelian ideas, and though this fact has no particular interest for us at present, there are some correlative results that may be of service.

Coupe No. 7, Canton de l'Etang, Forest of Parey, cut in 1885, had been last cut in 1839. It was now found to contain 748 *m. c.* in the standards of Class II and over. Allowing for losses by accident, to the extent of 25% in the 1st Class, and 5% in the IInd Class, it was shown as the result of M. Watier's measurements, that the reservation of 1889 had been as follows :—

21	Oaks, Age	25	Yrs. Girth	0·30	Hght	4 *m.*	Volume *m. c.*	15·1
221	Beech,	25	,, ,,	0 30	,,	4 ,,		
84	Hornbeam	25	,, ,,	0 30	,,	4 ,,		
140	Oak	50	,, ,,	0·53	,,	5 *m.*	Vol. 14·0 *m. c.*	
60	,,	75	,, ,,	0·94	,,	6 ,,	,, 21 2	86·2 × 1·9 = 163·8
24	,,	100	,, ,,	1 41	,,	7 ,,	,, 21·2	
16	,,	125	,, ,,	1 88	,,	8 ,,	,, 29·8	
97	Beech	50	,, ,,	0 78	,,	6 ,,	,, 24·1	32·8 × 2·1 = 68·9.
[illegible]	,,	75	,, ,,	1·47	,,	8 ,,	,, 8·7	
								248·0

The figures 1·9 and 2·1 are factors or coefficients ; 1·9 applied to oak or hornbeam boles gives the volume of the whole tree ; 2·1 applies to beech in the particular locality.

The above table shows that in 27 years, 248 *m. c.* or 66 *m. c.* per hect. became 748 *m. c.* or 200 *m. c.* per hect. For every *m. c.* reserved in 1839, 3 *m. c.* were found in 1886.

The annual increment of the standards therefore is $\frac{200 - 66}{27} = 5$ *m. c.*

Coupe No. 7, Canton de la Rappe, Forest of Vaudoncourt, was similarly treated. The loss by accident was put at 20% for 1st Class stems, and 3% for 2nd class, the reserves generally being less numerous than at Parey, and so much the less likely to get damaged in the fellings. Here it was found that 165 *m. c.* per hect. reserved in 1838, became in 28 years 423 *m. c.* or 99 *m. c.* per hect., 1 *m. c.* becoming 2·6 *m. c.*, the mean annual increment therefere was $\frac{99 - 38}{28}$ = 2·2 *m. c.* per hectare.

Coupe No. 8 of the Communal Forest of Velaine-sous-Amance is referred to by M. Broilliard in his Aménagement. Here, 56·8 *m. c.* and 56 steres of branchwood in 25 years became 135·2 *m. c.* of stems and 132 steres of branchwood. Here, in 25 years 1 *m. c.* becomes 2·4 *m. c.*, in 30 years it would become 2·7 *m. c.*

From the above facts it may be concluded that in 30 years, on good soil, the reserves triple their volume, perhaps a little less if they are purely oak. For some years past, the older classes have been numbered and belted. The extension of the practice to the 2nd. Class trees of all species would supply most valuable data by the end of the rotation. In some parts of India the practice exists of numbering the whole of the standards, which actually does prevent thefts fairly efficiently for a year or two, but the

full benefit of the work is lost because the staff is too weak to ever verify the standards remaining in any coupes older than the recent ones, and as a matter of fact, not only do the numbers disappear, but the trees themselves do the same.

Maximum volume of the reserve.—In the five coupes already mentioned, the volume of the standards was, at the time of felling :—

Aingeville	126 *m. c.*	per hect.	for a rotation	of 30	years.
Bulgneville	140	...	...	... 25	"
Mandres	208	...	...	... 35	"
Parey	200	...	...	... 27	"
Vaudoncourt	100	...	...	... 28	"

In coupes like Aingeville, Bulgneville and Vaudoncourt, it is evident that the standards might well be more numerous ; in the other two, the area left for the coppice seems reduced to its minimum. In No. 9 of the reserve quarter of the forest of Saint-Ouen, the coppice is aged 25 to 31 years, in oak and beech. The area being 10 hect. 21 ares, the standards amount to 853 *m. c.*, the abandoned trees to 1464 *m. c.*, total, 230 *m c.*, per hectare. This coupe is bastard high forest, one half of the area being without coppice. Hence it is apparent that 230 *m. c.* per hect is too much, while 200 *m. c.* per hect. leaves enough coppice to furnish the requisite 1st Class stems for reservation. Thus, the condition to aim at in marking is, to have 200 *m. c.* per hectare, covering about 40 ares, in the coupe when exploitable. To obtain this stock it will be necessary to reserve 65 to 70 *m. c.* per hectare, if the forest is oak and beech, 75 to 80 *m c.* if it is pure oak. Once the reserves are thus constituted, the felling will be 120 to 135 *m. c.* every 30 years, while the mean annual increment will be 4 to 4·5 *m. c.*

Proportionate numbers of standards. Wastage.—Every stem reserved does not become a mature tree any more than every child becomes a man. There are always some that perish by nature or accident. It is therefore necessary to know what allowance must be made for this waste in each class. Though small in the older classes, it is considerable in the youngest. Hence, in order to make sure of the 70 or 80 *m. c.* per hectare required to develop into 200 *m. c.*, it is necessary to reserve a certain proportion in excess, to allow for disappearances accidental or designed. What is this proportion? It varies for each class of each species and must be determined on the spot. There is thus a *coefficient of survival*, namely, the proportion which the trees that reach maturity bear to the number originally reserved If we have to reserve 100 trees of one class in order to obtain 89 trees of the next higher class, the co-efficient is ·8. M. Watier found that the co-efficient for first reservations varied from 90 to 75, according to the local chances of breakage or death, while that of the older classes went down as low as 40 on account of the inclusion of short-lived species exploitable at 60 years. He recommends therefore that the necessary 75 to 80 *m. c.* for oak and 65 to 70 *m. c.* for beech and

oak should be reserved in due proportion among the superior classes, with about 100 young stems additional at each felling.

The co-efficients of survival for standards may be applied as follows :—

100 I Class reserves	give	$100 \times 0{\cdot}8 = 80$	trees	30	years old
80 II Class ,,	,,	$80 \times 0{\cdot}6 = 48$	,,	90	,, ,,
40 III Class ,,	,,	$48 \times 0{\cdot}7 = 36$	,,	120	,, ,,
36 IV Class ,,	,,	$36 \times 0{\cdot}652 = 23$	,,	150	,, ,,

The volume of these might be :—

23 Trees of 2·09 *m.*	girth, at	4·6 *m. c.*	= 106 *m. c.*
36 ,, ,, 1·50 ,,	,,	2·3 ,,	= 83
48 ,, ,, 1·00 ,,	,,	0·9 ,,	= 43
80 ,, ,, 0·50 ,,	,,	8·2 ,,	= 16
			248

But this is too much, as the maximum has been already put at 100 *m. c.* The above figures must therefore be reduced in the proportion of 248 to 200, or four-fifths. Thus, making 80 first reserves, we shall get—

19 trees of 2·00 Girth,	at 4·6 *m. c.*	= 87	*m. c.*
29 ,, ,, 1·50 ,,	,, 2·3 ,,	= 67	,,
38 ,, ,, 1·00 ,,	,, 0·2 ,,	= 48	,,
65 ,, ,, 0·50 ,,	,, 0·9 ,,	= 13	,,
		201	

Of this number, the felling would include :—

19 trees	at 4·6 *m. c.*	= 87	*m. c.*
29—19=10 ,,	,, 2·3 ,,	= 23	,,
38—29= 9 ,,	,, 0·9 ,,	= 8	,,
65—38=27 ,,	,, 0·2 ,,	= 5	,,
		128	

And the reservation would include :—

19 trees	at 2·3 *m. c.*	= 44	*m. c.*
29 ,,	,, 0·9 ,,	= 26	,,
38 ,,	,, 0·2 ,,	= 18	,,
80 stems	...	...	
		78	

Measurement of the cover.—The division of the standards into size classes, and the measurement of their girth at breast height, have already been explained. The measurement of the cover is done as follows. Two guards are provided with a staff each and a tape. One guard places his staff directly under one edge of the crown, and holds the end of the tape touching it. The other guard goes to the other side of the crown, and takes the reading

up to his own staff similarly placed. They then repeat the operation at right angles. The officer carries a plumb line, and sees that the positions are correct. It is best to employ six men, four to measure the two diameters of the crown, one to take girths, and one to keep the register.

Relation between diameters of crown and stem.—Let the diameter of the crown be represented in the exploitable coupe by **D** and in the exploited coupe by D, the diameter of the stem being d, The results are shown in the following tables.

Table I—Cover of oak in the exploitable coupe.

Diameter d of bole.	Aingeville.		Bulgneville.		Mandres.		REMARKS.
	Diameter **D** of Crown.	Relation $\frac{\mathbf{D}}{d}$	Diameter D of bole.	Relation $\frac{\mathbf{D}}{d}$	Diameter D of bole.	Relation $\frac{\mathbf{D}}{d}$	
0·20	2·4	12·0	2·5	12·5	2·7	13·5	All measurements are in metres & centimetres. **D** is the mean of the trees reserved and of those abandoned. d is taken at breast high. The above remarks apply to all the tables.
0·25	3·0	12·0	3·3	13·2	3·2	12·8	
0·30	3·8	12·7	3·9	13·0	4·1	13·7	
0·35	4·5	12·8	4·6	13·1	4·8	13·7	
0·40	5·3	13·2	5·3	13·2	5·5	13·7	
0·45	6·0	13·3	6·0	13·4	6·3	14·0	
0·50	6·5	13·0	6·7	13·4	7·1	14·2	
0·55	7·5	14·6	7·4	13·5	7·9	14·3	
0·60	8·5	14·2	8·1	13·5	8·6	14·3	
0·65	9·2		8·6	13·4	9·0	13·8	
0·70			9·2	13·1	9·5	13·6	
0·75			9.6	12·8	9·9	13·2	
0·80			10·0	12·5	10·5	13·1	
0·85			10·5	12·4			
0·90			11·2	12·4			
0·95			12·0	12·5			
1·00			12·7	12·7			

Table II—Cover of oak in the exploited coupe.

Diameter. d of bole.	Aingeville.		Bulgneville.		Mandres	
	Diameter D of crown.	Relation $\frac{D}{\mathbf{D}}$	Diameter D of crown.	Relation $\frac{D}{\mathbf{D}}$	Diameter D of crown	Relation $\frac{D}{\mathbf{D}}$
0·20	5·3	26·5	5·2	26·0	4·9	24·5
0·25	6·5	26·0	5·6	22·4	5·4	21·6
0·30	7·6	25·3	6·6	22·0	6·1	20·3
0·35	8·5	24·3	7·5	21·7	6.8	19·4
0·40	8·9	22·2	8·2	20·5	7·5	18·7
0·45	9·5	21·1	9·0	20·0	8·4	18·6
0·50	10·3	20·6	9·9	19·8	9·4	18·8
0·55	11·0	20·0	11·9	21·6	10·6	19·3
0·60	11·7	19·6	13·2	22·0	11·3	18·8
0·65	12·4	19·1	13·4	20·6	12·7	19·5

Table III—Relation between the diameters of the crowns of oaks in the exploitable and exploited coupes.

Diameter d of bole.	Aingeville: Diameter D of crown in coupes exploited	Aingeville: Diameter D of crown in coupe exploitable	Aingeville: Relation $\frac{D}{d}$	Bulgneville: Diameter D of crown in coupes exploited	Bulgneville: Diameter D of crown in coupe exploitable	Bulgneville: Relation $\frac{D}{d}$	Mandres: Diameter D of crown in coupes exploited	Mandres: Diameter D of crown in coupes exploitable	Mandres: Relation $\frac{D}{d}$
0·20	5·3	2·4	2 2	5·2	2 5	2·1	4·9	2 7	1·8
0 25	6 5	3·0	2·2	5 6	3 3	1·7	5 4	3·2	1·7
0·30	7 6	3 8	2 0	6 9	3 9	1·7	6 1	4 1	1·5
0·35	8 5	4 5	1 9	7 5	4 6	1 6	6·8	4 8	1·4
0 40	8 9	5 3	1·7	8·2	5 3	1 5	7 5	5 5	1 4
0 45	9 5	6 0	1·6	9·0	6 0	1 5	8 4	6·3	1·3
0 50	10 3	6 5	1 6	9·2	6 7	1·5	9 4	7 1	1·3
0 55	11·0	7 5	1 5	11 9	7·4	1·5	10·6	7 9	1·3
0 ·60	11 7	8·5	1·4	13·2	8·1	1 6	11·3	8 6	1·3
0 65	12·4			13 4	8 6	1 6	12 7	9 0	1·4

Table IV—Cover of Beech in the exploitable Coupe.

Diameter d of bole.	Bulgneville: Diameter D of Crown.	Bulgneville: Relation $\frac{D}{d}$.	Mandres: Diameter D of Crown.	Mandres: Relation $\frac{D}{d}$.
0·20			4·6	23·0
0·25	5·8	23·2	5·6	22·4
0 30	6 5	21·7	6·4	21 3
0·35	7·1	20 3	7·2	20·6
0·40	7 6	19·0	7 8	19·5
0·45	8·1	18·0	8·5	18·9
0 50	8·7	17 4	9·1	18·2
0·55	9·4	17 1	10·2	18·3
0 60	10·2	17·0	10·9	18·2
0·65	11·7	17·4	11·1	17 1

Table V—Cover of Beech in the exploited Coupe.

Diameter d of bole.	Bulgneville.		Mandres.	
	Diameter D of Crown.	Diameter $\frac{D}{d}$	Diameter D of Crown.	Relation $\frac{D}{d}$
0·20			5·8	29·0
0·25	8·0	32·0	6·6	26·4
0·30	8·5	28·3	7·3	24·3
0·35	9·2	26·3	8·1	23·2
0·40	10·3	25·7	9·0	22·5
0·45	11·0	24·4	9·9	22·0
0·50	11·4	22·8	10·7	21·4
0·55	12·0	21·8	11·7	21·3
0·60	12·5	20·8	12·3	20·5

Table VI—Relation between the diameters of the Crowns of Beech in the exploitable and exploited Coupes.

Diameter d of bole.	Bulgneville.			Mandres.		
	Diameter D of crown in Coupe exploited.	Diameter D of crown in Coupe exploitable	Relation $\frac{D}{d}$	Diameter D of crown in Coupe exploited.	Diameter D of crown in Coupe exploitable.	Relation $\frac{D}{d}$
0·20				5·8	4·6	1·3
0·25	8·0	5·8	1·4	6·6	5·6	1·2
0·30	8·5	6·5	1·3	7·3	6·4	1·1
0·35	9·2	7·1	1·3	8·1	7·2	1·1
0·40	10·3	7·6	1·4	9·0	7·8	1·2
0·45	11·0	8·1	1·4	9·9	8·5	1·2
0·50	11·4	8·7	1·3	10·7	9·1	1·2
0·55	12·0	9·4	1·3	11·7	10·2	1·1
0·60	12·5	10·2	1·2	12·3	10·9	1·1

From the above tables certain conclusions may be drawn. It has been already stated that the cover of the tree abandoned to felling is, or should be, smaller than that of the tree reserved. Table I shows that for oak and light-demanding species the relation $\frac{D}{d}$ in the exploitable coupe is fairly constant, increasing slightly with the diameter of the tree up to 0·55 *m.* and then again decreasing.

Table II shows that in the exploited coupe the relation $\frac{D}{d}$ diminishes as the diameter of the trees increases, but it remains always greater than the corresponding relation $\frac{D}{d}$ in the exploitable coupe.

Table III shows that the relation $\frac{D}{D}$ between the diameters of crown of tree of the same size in the exploitable and exploited coupes, varies inversely with the size of the trees. It is always greater than unity, and varies from 1·3 for old trees to 2 for young ones.

Immediately after the felling, the oak crowns, no longer confined in the coppice, suddenly spread out. For trees of 0·20 diameter of stem, the diameters of the crowns are as 2 to 1, and the areas as 4 to 1. Hence the necessity of distinguishing clearly between measurements taken in an exploitable, as against an exploited, coupe. Any confusion on this point must lead to grave error. There is, of course, a direct causal relation between the expansion of the crown and the increment of the stem, but it is not necessary to assume that the increase of crown carries a corresponding increase of leaf surface. Indeed, this is not proved, but whether it be so or not, the leaves, even without any increased surface, obtain a much greater share of light and heat, which translates itself into increased activity and corresponding increase of wood manufacture. The relation $\frac{D}{D}$ shows how much a light-demanding species suffers, not only from the surrounding coppice, but from the reserves of other species, notably those with heavy cover.

Therefore attention must be paid to the due spacing of the former, and if the fellings are preceded by thinnings, advantage should be taken of the opportunity to free a sufficient number of promising stems for the future standards.

The remaining three tables refer to beech, a shade-bearing species. Table IV shows that in the exploitable coupe the relation $\frac{D}{d}$ varies inversely with the size of the trees, but it is always greater than the corresponding relation for oak. It follows that for trees of the same size, the beech has always a larger crown than the oak. This is natural, since the beech refuses to let itself be oppressed by the coppice. Tables V and VI together show that in the exploited coupe the relation $\frac{D}{d}$ again varies inversely with the size of the trees. For trees of the same size, it is always greater than the corresponding relation $\frac{D}{d}$ in the exploitable coupe. The same two tables show that the relation $\frac{D}{D}$ between the diameters of crowns of trees of the same sized trunk in the exploitable and exploited coupes, varies inversely with the size of the trees. It is always less than the corresponding relation for oak. Thus, like the oak, the beech puts on a rapid increase after a felling, but to a less degree than the oak, because it was in less need of release. Age for age, the beech is always larger than the oak,

one reason being that it does not suffer its neighbours to encroach. The oak does, and for this reason it is found necessary to specially free periodically certain historic oaks in the forest of Saint-Ouen-les-Parey. It may be of interest to mention these oaks: they are the *Chene des Partisans*, 7·40 girth; the *Chene Henri*, 5·20 girth; the *Chene Charles* X, 5·25 girth, and the *Chene de la Republique*, 5·0 girth; not a bad show for one forest. In marking a coupe, this expansion of the crown must be borne in mind, and the spacing carefully attended to, or it may happen that trees which seemed far enough apart may close up their crowns and crush out the coppice in patches.

Variation of cover during a coppice rotation.—In the exploitable coupe the diameter of oak crowns is 13 to 15 times that of the stem, in the exploited coupe it is 10 to 25 times. The annual increase of stem diameter is 6 to 7 millimetres, or about a fourth of an inch. Applying these figures in the exploited coupe, where measurements are easy, we may *form an idea what the cover will* be like by the next felling. For instanee, a stem of 0·30 diameter in the exploited coupe will have a crown of 0·30 by 25·3=7·6 *m.* Just before the next felling, the stem will be 0·48, and the crown 0·48 × 13 3=6·4 *m.* An oak of 0·50 in the exploited coupe has a crown of 0·50 × 20·6=10·3. Just before the next felling the stem will be 0·68, and the crown 0·68 by 14·2=9 7 *m.* It appears strange that the crown of the same tree should be less in the exploitable coupe than it was when the coppice was two or three years old, but such is the case, and if we add the cover of a hundred or so young stems per hectare, reserved but not counted in the exploited coupe, which have now acquired a diameter of about 0·25, we reach the curious result that in the exploitable coupe of oak, *the cover of the reserves is approximately what it was when* the coppice was two or three years old. This is explained by the fact that in the exploitable coupe all the existing standards are measured, whether flourishing or in process of suppression, whilst in the exploited coupe all the latter have been cut out, leaving none but fine trees. For mixed oak and beech, the cover over coppice of two or three years old is about four-fifths of what it will be when the coupe is exploitable In this case, equality only occurs when the coppice is 5 to 7 years old. From the above it may be deduced that in the course of a coppice rotation the cover of the standards passes through a maximum, the process being somewhat as follows. Previous to the felling, all the standard oaks are crowded by the coppice, under the influence of which the branches are pressed *closer to the trunk, some of the trees even becoming suppressed.* At the felling the coppice disappears, and with it the suppressed trees. The finer trees only remain, and these are suddenly isolated. The branches, now at liberty, in their search for heat and light, and partly through their unsupported weight, extend themselves more horizontally, the angle of insertion increases and the crown tends to become more globular. The expansion, sudden at

first, becomes gradually slower, and for 6, 8, or 10 years, so long as the trees are isolated, the cover increases. About the tenth year, the coppice, having grown up, begins to force the branches closer to the trunk, so that, from this time on, the cover diminishes till the end of the rotation. By the time the felling arrives, a certain number of the trees, no longer promising as reserves, come under the axe. In the case of a conversion, the mixed coppice of beech, hornbeam, &c., being kept standing to the age of 50, 60, or more years, would tend to suppress all the oaks, so that in order to preserve these as seedbearers, repeated thinnings are necessary.

The word "cover" is capable of two meanings In the present case, it means the area directly below the crown. But in a physiological sense, this definition no longer fits. Other factors, such as the height of the crown, the density of the shade it gives, &c., enter into the question This fact is rendered sufficiently obvious by a comparison of the undergrowth found below a high crown with thin shade, and the absence of any under a low crown with dense shade, both being of the same area. Two terms are required, one to indicate the area, and the other the degree of nocuity. The latter would have to take the form of a co-efficient deduced from several elements. Indian foresters have unfortunately little time for experiments, but there is a wide field awaiting investigation and the above is an indication of one opening alone out of many.

F. GLEADOW.

IV.—REVIEWS.

Schlich's Manual of Forestry, Vol. V. 'Utilization' by W. R. Fisher.

Last year we reviewed Mr. Fisher's admirable work, or rather translation, on Forest Protection, and we are now called upon to do the same for the bulky but most valuable *and interesting* work before us, on 'Forest Utilization.' In a country like India, where Forest officers have to deal with huge forest areas, circumstances generally prevent too elaborate and detailed systems of forestry being adopted, and the demand, in *the case of timber, chiefly falls* upon a few special kinds, so that 'Utilization' becomes almost of more importance than sylviculture and the energies of the staff have at the outset to be directed more to the supply of the country, *the development of the trade and the best means of bringing to* notice the various forest products of value, than to detailed measures for reproduction. It is not, therefore, to be wondered at, that in India we have hitherto been obliged by circumstances to pay much *attention to the subject of 'Utilization' and that the systems* adopted for the extraction of forest products will bear comparison with those in force in any other part of the world. The arrangements for the cutting, logging, conversion and extraction of timber *from the teak forests of Burma and from the deodar forests of the*

North-West Himalaya have given the greatest credit to Indian Forest officers, while their work in the supply and development of the trade in such produce as sandalwood, redwood, india-rubber, myrabolams, rope-grasses, turpentine and resin, tanning barks and dyes, has been of the greatest importance, an importance the more worthy of note, perhaps, as the work has been so quietly and modestly done. There is, no doubt, still an enormously wide field in the Indian forests for development of trade and the more complete utilization of resources, and to help us in working to this end such books as that which Mr. Fisher has now given us will be of the greatest assistance. We have already in India a manual on the subject, embodying the course taught at the Forest School of Dehra Dun, namely 'The Utilization of Forests' by Mr. E. E Fernandez, an excellent work, but one which, of course, being applicable only to India, is, as Mr. Fisher says (p. vi) "less comprehensive" than the volume now under review.

It must not be supposed that Mr. Fisher claims for his book an originality to which it really is not entitled; for, as the title page tells us, it is 'an English translation of "Die Forstbenutzung" by Dr. Karl Gayer, Privy Councillor of Bavaria and Professor of Forestry at the University of Munich.' To some of us, "Gayer's Forstbenutzung" has long been a regular companion, but to those who know little or no German, and to those who, well as they may understand German, yet prefer to read English, Mr. Fisher's work will be most acceptable, and especially as additions of importance have been made from the 'Technologie Forestière' of M. L. Boppe of the French National Forest School at Nancy; and notes of great value have been given from time to time from the Indian experiences of the translator and his friends in our Indian service. It is only right for us to mention, further, that the work has necessitated the laying out of a considerable amount of mone, so that it may be hoped that Indian Forest officers will support and assist Mr. Fisher and Dr. Schlich by helping them to dispose of their stock on hand.

The Introduction to Mr. Fisher's work thus defines 'Forest Utilization'—"a systematic arrangement of the most appropriate 'methods of harvesting, converting and profitably disposing of 'forest produce, in accordance with the result of experience and 'study"; and the work itself is divided under three heads or Parts, viz:

I. Harvesting, conversion and disposal of forest produce;
II. Harvesting and disposal of minor forest produce;
III. Auxiliary industries despending on forestry.

In Part I the first subject discussed is that of the 'Technical properties and qualities of wood' (Chapter I). We are told how wood consists of three kinds of elementary organs, viz: 'wood cells,' 'wood vessels' and 'wood fibres,' which do not, however, all occur always at once in the same species; and how, in addition, may also be found 'resin cells' and 'medullary rays,' the relative values of woods depending largely on the arrangement and distribution of these organs. Under this subject comes a discussion on the classification

of timbers according to the relative amount of heartwood and sapwood given by the tree ; and here Mr. Fisher brings out his own classification of timbers into—

(*a*) Heartwood trees, *i. e.*, trees which possess a true heartwood.
  (i) Broad zones of sapwood—oak, elm, walnut, Scot's pine, etc.
  (ii) Narrow zones of sapwood—sweet-chestnut, mulberry, larch, etc.

(*b*) Trees with incomplete heartwood, *i. e.*. where there is no distinction in colour, but where the heartwood no longer takes any share in the vital processes—spruce, silver-fir, beech.

(*c*) Sapwood trees, *i. e.*, trees with no clear distinction between the heartwood and sapwood—ash, hornbeam, maple, alder &c.

This classification is new to us, but we think that in practice it cannot always be easy to distinguish between the woods of the last two classes.

In discussing the 'specific gravity' of woods, Mr. Fisher has given as the admirable plates taken from Mons. Boppe's 'Technologie' which shew the different types of oak and spruce wood according to speed and regularity of growth to illustrate his discussion of relative density. In classifying woods according to specific gravity he adopts the following scale :—

Very heavy woods 0·75 and upwards, *e. g.*, yew, ash, pedunculate oak.

Heavy woods 0·70 to 0·75, *e. g.*, sessile oak, hornbeam, beech.

Moderately heavy woods 0·55 to 0·70, *e. g.*, elm, maple, birch, larch.

Light woods 0·55 and less, *e. g.*, alder, pine, spruce, poplar.

In India we do not usually talk of 'specific gravity,' but of the 'average weight per cubic foot,' so that the classes above referred to would be about : 47 lbs. and over, 44 to 47 lbs. 34 to 44 lbs. and 34lbs. and under. In India, of course, most of our chief woods would be 'very heavy,' and indeed we should require a still higher degree of comparison to bring in these woods which are heavier than water and may even run up to 92 lbs. (sp.g. 1·31) in the case of *Hardwickia* and 76 lbs. (sp. g. 1·21) in that of *Mesua*.

The question of 'hardness' is then discussed and the fact is pointed out—a fact which was ascertained from Prof. Gayer's own experiments—that some of the softer woods like the lime, willow and poplar shew greater resistance to the saw when freshly felled than the Scot's pine, larch and even the oak. Under the heading of 'pliability' comes the question of the elasticity and flexbility of woods, and then our author proceeds to the discussion of transverse strength, a subject which is rather briefly treated, we suppose because it is supposed to belong more properly to the domain of Forest Engineering.

'Defects and Unsoundness' are fully treated, with excellent illustrations, among which fig. 11 may be recommended as an excellent picture of the results of the enclosure in the wood of a dry branch and fig. 12 as one of the results to be obtained by pruning such branches in good time.

Chapter 2 discusses the 'Industrial uses of Wood' in three subdivisions,—(i) timber, (ii) firewood and (iii) woods arranged according to their uses. Under the first of these comes the description of the various methods of conversion according to the class of material which is required. We are shewn how saw-cuts should be made so as produce the largest amount of radial section wood, such wood shewing a better silver-grain and standing friction better; how timber may be split for use in palings, casks, etc.; what are the characters required for timber used in building and construction; what are the descriptions and the shapes of pieces in use for paving blocks, mine-props, railway sleepers, etc.; and then the pieces used in ship-building are enumerated and described. In regard to the latter industry, our author explains how wood has come to be so largely replaced by iron of late years in shipbuilding work, but that there is still a very large amount of wood required for smaller vessels and for fresh-water barges. We note that he does not mention the very extensive use of teakwood as a backing to the iron-plates of men-of-war. Under 'Miscellaneous use' come wheelwright work, the building of railway carriages and trucks, cooperage, roof-shingles, wood wool, now so largely used as a packing material, matches, pencils and musicial instruments, while by no means the least of the many industries mentioned is that of wood-pulp, the demand for which bids fair to become enormous in a few years and capable of requiring the careful afforestation of almost every spare acre of otherwise waste land. Mr. Fisher tells us that in the years 1892-1894 inclusive, no less than 200,000 acres of forest were denuded in North America to satisfy the demands of 210 paper factories; and that in 1892 there were in Germany 600 factories, consuming 35.000,000 stacked cubic feet of wood in the production of 200.000 tons of wood-pulp, but he adds that there is *now an excess of production over demand*. That such is the case is very probable, because of late in Europe the demand for fuel wood has much decreased, so that owners are likely to try and recoup themselves by selling their material for paper pulp, but as the consumption of paper increases yearly, the demand for paper material must also increase, and it would seem doubtful if, on the whole, existing forest areas will, after a few years, be capable of meeting it. Under 'Firewood' we are given but a very short chapter, chiefly because such subjects as the manufacture of charcoal are treated further on; and then comes a useful table of the chief European and exotic woods arranged according to their uses. We should have liked to see the list of exotic woods much extended, for there are a large number of kinds known only by trade names, whose identification would be of great interest. A few days ago, for

instance, we come across a furniture wood of great beauty, 'partridge wood,' but we have very little notion what it is and where it comes from. It is not in Mr. Fisher's list, and the information given by Holzappfel is rather meagre,

In Chapter 3 we have a full account of the methods of 'Felling and Conversion of Timber,' beginning with the organization of labour gangs, the implements used, the seasons of felling and the methods of felling and first rough conversion. The different kinds of axes and saws in use are fully described with appropriate figures, and there are also excellent pictures to explain how best trees can be felled with either of these implements. Then comes an account of the chief methods adopted for clearing the felling-area, sorting the converted material and recording the yield, and here we find the methods dragging, sliding and sledging explained in full.

The 4th Chapter treats of 'Land Transport,' and we are glad to see the importance attached to good forest roads as so much more durable and so much more useful for general purposes than slides and sledge roads. This chapter is specially illustrated by a photographic picture of the well-known Chamba log slide, and Mr. Fisher has also briefly described the Lambatach plank slide and the Deota wet slide in the Himalayan forests. No modern book on the subject would be complete without an account of forest tramways, both railways and wires; and the latter, which we believe to be the cheapest and *the* system of the future, we should have liked to see treated in greater detail.

In Chapter 5 comes 'Water Transport,' so largely employed in Germany and here treated at considerable length. We are glad to see that the boom on the Jumna at Daghpathar has been briefly described, but think that those which have so long done such excellent work in Burma, though perhaps of not so elaborate a construction, might also have been referred to. In comparing, in Chapter 6, land with water transport, Mr. Fisher comes to the conclusion, a conclusion which we heard ourselves given by the Forest officers in the Austrian Alps, that wherever possible land transport is preferable.

Chapters 7 and 8 give an account of Wood Depôt, and their management and of the business involved in the disposal and sale of wood. This last chapter will be found interesting by Indian Forest officers who often have to decide whether sale of material standing in the forest or the extraction and sale by departmental agency is the most advantageous in the special circumstances of different localities.

Part II, which discusses the 'Harvesting and Diposal of Minor Forest Produce' devotes special chapters to (1) barks; (2) fodder; (3) field crops in combination with forestry; (4) fruits and seeds, gathered for reproduction works, or allowed to be eaten or removed or collected for industrial use; (5) dry fallen wood; (6) stone

and other minerals ; (7) litter and (8) resin-tapping, while a ninth chapter treats of other but less important items. The chapter on barks treats chiefly, of course, of those used for tanning in Europe and is a very interesting one. It begins by a brief description of the process of tanning and the explanation that there are three processes : *tanning*, the preparation of leather with substances containing tannin ; *tawing*, that by means of aluminium salts, used for kids and other white leathers, and *shamoying*, that by means of fats or oils and producing wash leather ; besides a fourth more recently discovered process by means of chromates. It then enumerates the different materials in common use (by the way it is *Uncaria Gambier* not *U. Gambia* that gives the astringent, and it should be *Myrobalams* not *Myrobalans*) and then proceeds to describe in full the harvesting of oak bark, spruce bark, birch bark, larch bark and willow bark. It is the latter that is used in tanning Russian leather, the pleasant scent being given by a soaking in the oil distilled from the external white layer of the birch.

The question of fodder includes that of pasture and the discussion of this subject by Professor Gayer is very interesting. We wish we had space for some long quotations for they might be of use in this country, but the main conclusion, is that forest pasture, though affording means of utilizing a good deal of produce which is available and occasionally serving to suppress dense growth and allow young trees to obtain light, or to 'wound the soil' and allow resting places for seed, has many disadvantages of greater importance. In Germany, apparently, except in high mountain districts, forest pasture is now largely replaced by stall-feeding. We wish this could be the case in India to the great improvement of the quality of the cattle. The question of field-crops in combination with forestry is also treated at length, and we learn that a practice akin to our Indian 'jhuming' is still carried on in Finland, Northern Sweden, parts of Russia, and here and there in the Alps and Carpathians. But the chief cases in which a system is resorted to of mixed agriculture and forestry are : (1) the *Schmoren* or *Schmoden* system in Germany, in which, after a clear felling, crops are cultivated for two years and the area is then restocked artificially ; (2) the *Hackwald* and *Waldfeldbau* in which crops are grown in oak coppice for about two years when the new forest growth is left to come on.

So, too, is the question of 'Forest litter' one of considerable importance in Europe, the chief materials removed being : (*a*) dry fallen leaves or needles : (*b*) moss and grass; (*c*) forest weeds, such as broom, heather, fern, reeds, &c. ; and (*d*) branch loppings of coniferous trees. The evil effects of the removal of such things are fully explained, and it is recorded that from careful observations made by Dr. Bleuel in the Spessart "by the annual removal 'of litter for 23 to 30 years in older beech-woods, the wood-incre-'ment fell in different cases by 32, 39, 42 and even 56 per cent. on

'inferior soils; but that on good basalt, in the Rhone Valley, the 'loss was only 8 per cent. In Scotch pine-woods of good quality, 'the loss, where the litter was removed annually, was 7·5, 9·3 'and 10·9 per cent."

The chapter on resin-tapping is taken from Boppe's 'Technologie Forestière,' as the procedure is not followed in Germany with pine, and in the last chapter in the book is given an account, taken from our pages, of the industry of resin and turpentine as practised in Gascony. These methods are all well known to our readers, but it is not perhaps so well known that in Germany the spruce is tapped and in Austria the larch and black pine. In speaking of the resin-work in Jaunsar in the North-West Himalaya, Mr. Fisher says, "it is more profitable to sell the crude resin than to distil it," but he forgets that the demand for crude resin is very limited, indeed, while that for turpentine is very large, much larger than the chír pine forests available are capable of producing. The less important articles of minor produce enumerated in Chapter 9 comprise grass-seeds, herbage, wood-wool, vanillin (obtained from the cambium layer of conifers), mosses, 'Knoppern' galls, truffles, edible fruits, limebast and several other small items are mentioned as of interest.

In Part III 'Auxiliary Forest Industries,' an account is given of the 'antiseptic treatment of timber' and the chief methods of injection. Then forest saw-mills are described and the processes of wood-distillation and the manufacture of charcoal, also the digging and preparation of peat.

From our account it will be seen that Mr. Fisher's work is one of a very comprehensive character, and is full of subjects of the greatest interest to all who have any concern with the management of forest property in any country. We strongly recommend its study to our readers.

The volume we have attempted to describe forms the 5th and final one of the Manuals issued from Coopers Hill under Dr. Schlich's able supervision. As our readers are aware, the *first* volume, which is now in its second edition, treats of the "Introduction to Forestry" and includes the principles of sylviculture; the *second*, of which a second edition may soon be expected, of the "Formation and tending of woods or practical sylviculture"; the *third* of "Forest management" with the preparation of working plans; the *fourth* of "Forest protection." All these have, as they appeared, been noticed in our pages: the first three having been done by Dr. Schlich himself, the last two by Mr. Fisher. They form a professional series of the greatest value, which should be in the libraries of all English-speaking Forest officers. They represent a great amount of hard work and confer much credit on their authors. Financially, they have not perhaps been as successful as had been hoped, especially the last three volumes, and it is greatly in the hope of attracting attention to them and furthering their sale that we have in the present review of the 5th Volume,

and in our review in our number for January 1896 explained in so much detail their scope and objects. We congratulate Dr. Schlich and Mr. Fisher on the completion of this great work, and hope that the financial success of the series will soon be as great as is their practical value.

[illegible]

The Rubber Forests of the Hukong Valley.

The report of Mr. H. N. Thompson, Assistant Conservator of Forests, on the Hukong Valley and Upper Namkong basin, coneains much interesting information on the fauna and flora of that region. It will be remembered that a survey party left Mogaung early last year to meet the party under Mr. Way from Assam engaged in surveying the Hukong Valley in connection with a railway from Burma to Assam. Mr. Thompson accompanied the Burma party, and explored the forests between Mogaung and Ningbyen, the meeting place of the two parties, and the country around Ningbyen. Mr. Thompson has compiled a mass of useful information on the forests in general, and in particular on the occurrence of trees which would yield timber suitable for railway sleepers and concerning the rubber trade. With that section of his report which treats of indiarubber, we shall briefly deal. As Mr. O'Bryen pointed out in his report a few years ago on the rubber forests of Upper Burma, the tree in the Hukong Valley is not a gregarious one. Mr. Thompson tells us that it appears scattered generally through the dense evergreen forests, but nowhere does it reach the density per acre of an average teak forest. "Occasionally, a family group of four or five trees may be met with; these are very rare, indeed, and the usual thing is to come across a mature tree every 200 or 300 yards in the richer forests." At the headwaters of the Namkong Chaung the average was not quite one large tree to every two acres. When the tree is surrounded by dense shade, to get to the light it grows to enormous heights, and some of those seen by Mr. Thompson were the largest trees of any species he had ever seen. So exacting is its demand for light that no seedlings were in the soil, but were invariably growing at a great height from the ground on other trees. A few illustrations show the young seedling growing "up the stem of its host, encirling the latter with its aerial roots and sending them downwards towards the ground till they form great supports on which the main trunk of the fig stands; meanwhile the host is gradually killed off and eventually disappears altogether and the rubber tree is left standing on five or six or even more thick aerial roots." The *ficus elastica* appears to be able to accommodate itself to many varieties of soil, and apparently grows best at a considerable altitude. Thus, Mr. Thompson records, it grows in abundance on Loimaw hill at an altitude of 5,000 feet, and is reported in various other high altitudes in that region. The Kachins say it does not grow where there is snowfall, but this seems doubtful.

The tract north of the Tanaikha is still the richest in the valley but the difficulties of transport are increasing as the more accessible trees have been worked out. Here a Chinaman Law Lawkha has a practical monopoly of the market. On the spot the price of rubber is two rupees per viss.* A few years ago a trade route was started across the mountains to Myitkyina, but the trader who opened it was murdered, probably, Mr. Thompson thinks, at Law Lawkha's instigation, and the blackmail levied by the Sana Kachins has killed the trade on that route. Some of the rubber around the southern basin of the Tanaikha is supposed to be taken down the Chindwin to Kindat, but this seems doubtful. The natural and shortest route is down the Nampyu to Ra and Palawbum and thence by mules to either Laban or Tingring, and so by boats and mules to Kamaing and Mogaung. With regard to the output of this tract, *i. e.*, from the forests lying at the sources of *the Nampyu to the west of Maingkhwan, Mr. Thompson* says it is very difficult to estimate it. "No reliable information can be obtained from either the Singphos or the Chinese traders employed in buying it, as both parties are interested in keeping the real state of affairs dark. Of course the usual cry is that the forest is getting worked out, that they have now to search for indiarubber at great distances from the lines of export, and that consequently the duty levied by us ought to be reduced. The fact, however, still remains that the local Sawbwas have in no way whatever reduced the tax levied by them on rubber collected in their districts or passing through to other places. I questioned four of the most influential Chinamen living at Laban, and who are agents of the large Bhamo and Mandalay firms, as to the out-turn from this portion of the valley during the present season ; but their statements were so very conflicting and contradictory that no reliance whatever could be placed in them, and under such circumstances it would be misleading to give any figures......As a single instance of the contradictory statements given by the Kachins, I may say that they informed me repeatedly that the yield of a large unworked indiarubber tree in one season does not exceed ten viss—a very different figure from that usually given, and which of course is too low, as I have personally seen about double that quantity extracted from a large tree." The rubber forests at the headwaters of the Namkong Chaung are rich in rubber. The tree grows in abundance along the banks of the smaller streams and is also frequently met with on the higher slopes of the hills. On these hills Mr. Thompson found the *ficus elastica* attaining as great a height as 200 feet and a girth round the outside of the aerial roots of 100 to 130 feet.

The only forest produce collected in the tracts examined by Mr. Thompson appears to be rubber, and the Kachins from far

* A viss = 3·65 lbs.

and near come in to collect it in the dry season. "During my visit to the Upper Namkong and Namsong basins, I twice came across 'octrois' built on the edge of the streams by Singphos from Palawbum and the Amber mines. Toll on all rubber brought down these streams from their headwaters was collected at these stations and none was allowed to pass unless this tax was paid. It was usually taken in kind and amounted to much as ten per cent., the collectors having to pay ten viss for for every hundred collected by them. The Singphos from the, Hukong Valley must have known that they were poaching in these forests, as they decamped as soon as they heard of my arrival." One local viss, it seems, is equal to one and a half standard viss, so the Chinamen must make a very good thing out of it. The Chinamen of the district are all engaged in the rubber-trade. "Great quantities of rice, silk pasos, gaungbaungs, &c., and stores, are kept by them and sold to the Kachins (at ruinous rates) who pay the price of the goods in indiarubber."

Mr. Thompson tells us that most of the indiarubber from one of the tracts, reported on by him, that is the whole drainage area of the Taron river above its junction with the Gedu affluent, is exported to Assam across the passes on the Patkoi. Much valuable information on this branch of the subject was collected by Captain Swayne, one of Mr. Way's party, and embodied by Mr. Thompson in his present report. The Nagas reap their crops in December and then set off for the rubber forests. Mr. Way's party met small bands of them on their way to the forests. Every tree in the basins of the Loglai and Taron is known and their positions are pointed out from father to son. It may be taken as correct that the rubber collected in the forests north of the Gedu confluence goes to Assam, while that collected in the forests south of the Gedu goes down the Hukong Valley. All the rubber that goes to Assam is carried by Naga coolies, who can always be had after the crops have been gathered and who are probably more efficient when working in their own country than any other coolies in India. Taronku, the great rubber centre of the tract under notice, is situated at the Taron-Gedu confluence, and the most valuable portion of the forest lies up the Taron river to the Chaukkan pass, along the route traversed some years ago by Colonel Woodthorpe and Major Macgregor. At Taronku a fee of Re. 1-8 or three seers of rubber is levied on every man who wishes to cut rubber in the forest. Besides this fee, Namyung village also collects tribute from the cutters passing through it. Rubber in this tract is getting scarce every year, as the trees are overworked, and it often takes a man no less than forty days to collect a coolie load of rubber. Most of the trees seen by Mr. Way's party had been tapped, and up the Loglai and Turong rivers the trees near the streams are either dead or dying from being overworked. Here the Singphos entirely control the Nagas

and stand to them, says Mr. Thompson, in very much the same position as a tea-planter and his coolies. Their word is law and is enforced by a very few Singphos over a great number of Nagas. The number of rubber-cutters who leave their villages for the Turong forests is known, and even if they succeed in evading the impost of the Singpho villages through which they pass, they would inevitably in the long run have to pay up. The rubber when first collected is fairly pure, but the Nagas have learnt from the native bunnias the trick of adulterating it with earth and stones, and so Assam rubber is not looked on with favour by Calcutta brokers. It may be added that the same applies to the rubber that finds its way into the Rangoon market, the Chinamen being adepts in skilfully concealing in the rubber earth and stones, principally the latter.

With regard to protecting the rubber forests in those remote regions, Mr. Thompson rightly says that in the absence of any means of enforcing the Forest Rules on the subject, it is not likely any attention will be paid to them. Sawbwas informed him that they are unable to enforce the rules or interfere in any way with the collectors. On this branch of the subject Mr. Thompson writes :—" Regarding the Hukong Valley itself, I think we are powerless to protect the indiarubber forests by any legislative methods, unless we are prepared to take the country over and administer it directly. The Singphos are an exceedingly independent race, and at present really recognize no one as masters. Under these circumstunces if we are not prepared to take over the country, and if we still wish to preserve the rubber forests from extermination, there is only one course left open to us, and that is to put a prohibitive tax on all rubber exported to the Myitkyina district from that Valley. Of course there will be a great outcry from the Chinese firms engaged in the trade and from others, but unfortunately the choice of alternatives is very limited, and no half measures are possible. The forests must either be completely protected or left alone ; the Singphos would appreciate no other course of action. . . . The *protection of rubber trees growing* in forests situated within our sphere of direct administration, though a difficult matter where Kachins are concerned, need not present any really serious obstacles, and it is possible that if reserves are made of the richest areas, and the local Sawbwas in whose jurisdiction the reserves would be situated were induced to interest themselves in the protection of the forests, and that the subordinate forest officials appointed to supervise them were selected from amongst some of the better class of Singphos, a great deal may be done towards the protection of this tree."—*Rangoon Gazette.*

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Obituary—Mr. James L. Laird MacGregor.

Indian foresters will have learnt with the deepest regret of the sad death of Mr. J. L. Laird MacGregor, Conservator of Forests, Bombay, on the 28th of February last, whilst following up a tigress he had severely wounded ; he was charged by the animal and received such serious injuries that his death resulted on the following day. He died at the beautiful village of Supa, situated in the heart of the glorious North Canara Forests he loved so well.

The dead body of the tigress was found subsequently about 200 yards from the spot where she had mauled Mr. MacGregor, and it would appear that she died almost immediately after the occurrence.

His death is keenly felt by all who knew him. A thorough gentleman, a keen sportsman and the very soul of honour, he was respected and liked by all with whom he came in contact.

Mr. MacGregor was born on the 9th of February 1848 and originally selected the Army for his profession, and he served for a short period in a British regiment as a subaltern, but the newly created Indian Forest Service offering greater attractions to his adventurous spirit, Mr. MacGregor, after passing the entrance examination of the Indian Forest Department, went through a course of training at the German School of Forestry at Tharandt, and was sent out to India. Upon his arrival in this country in January 1872 he was appointed to the Punjab Administration where he served about 18 months and from there was transferred to the Bombay Government and was posted to the Belgaum Division where he served as Divisional Forest Officer until in December 1886, upon the retirement of Colonel W. Peyton, he was appointed Conservator of the Southern Circle.

The Southern Circle of Bombay, including as it does the magnificent teak-producing areas of North Canara, as well as the valuable fuel forests of Belgaum, is one of the most important charges in British India.

Prior to the appointment of Mr. MacGregor as Conservator little or nothing had been attempted in the way of systematic management, and it devolved upon that officer to introduce the principles of scientific forestry and to commence the task of breaking up these vast masses of unregulated forests into workable series and substituting an orderly in the place of what had been hitherto a haphazard system. Only those who served under Mr. MacGregor can realize with what zeal he applied himself to this arduous duty which unfinished, though far advanced, must now be left to his successors. It may be safely said that the essential principles which guided him during his administration of the forests were simplicity and accuracy in organization, efficiency in protection and due attention to financial results. His views in regard to this latter have been the subject of controversy on the part of Forest officers in this country, but it is probable that his natural shrewdness made him cognizant of the fact that the British as a nation are not greatly devoted to forestry in the modern sense of the term, and that in this as in other matters they are more susceptible to large and quick returns than to other considerations.

During his tenure of office much has been effected in the shape of organization and much more in the form of protection. Working-plans have been made or are in progress for all the more important forests of North Canara and Belgaum : fire-protection has become a well established reality and the greatest attention has been paid to the subject of reproduction. In short his career as Conservator has been a record of good and honorable service, beneficial alike to Government and the forests of which he was in charge.

Amongst the members of the subordinate 'establishment his name has served as a symbol of honest and upright dealing, whilst by his own brother officers he was respected for his intelligence and keen sense of duty and esteemed for his unfailing geniality and thoroughly good nature. In his death the Forest Department has sustained a great and his friends an irreparable loss.

As an author, Mr. MacGregor will be remembered for his 'Organization and Valuation of Forests' published in 1883 and his 'Forest Organization for Beginners' which appeared in the *Indian Forester*. Both are works of great merit, receiving much attention at the time of their publication and raising their author to a very high place amongst the European foresters of the day.

The Forests of Prussia.

M. Hueffel, Professor at the Nancy Forest School, has just published an abridged French translation of *"The Forest Statutes of Prussia"* by M. Donner, Head of the Prussian Forest Service. The forests of that Kingdom comprise 8,192,500 hectares, or

23½% of the whole country. Private owners possess a little more than half of the total, the State and the Crown possess nearly ⅓rd, communes and public institutions own the remaining 1/6th. The principal forest regions are the Eastern sandy plains and the Western mountains. In the East, *Pinus sylvestris* alone covers 3,000,000, hectares, or ⅔ths of the entire area in the provinces of Prussia, Brandenburg, Pomerania, and Posen. The whole Kingdom contains 4,346,000 hectares of this tree, the average production of which is put at 3·29 c. m. per hectare, 0·81 c. m. of which is large timber. In the State forests, the possibility is put at 3·03 c. m., whilst in Saxony it is 6·45 c. m. and in Bavaria 5·13 c. m. The net revenue from these State forests is 25·57, 65·69, and 39·14 marks (or shillings) respectively.

"The administration considers that the forests, whether 'belonging to the State, or to private persons, are a property which 'we have received, not made, and which it is our duty to hand 'down intact to our successors. Indeed, the effects of forests 'upon climate, water supply, health, &c., render them indispensable 'to the equilibrium of every inhabited country. Private owners 'are tempted to ignore this responsibility, and the results of dis-'forestment have been that large areas have been rendered sterile, 'moving sandhills along the sea have covered fields and villages, 'and threatened inland navigation, the accumulated vegetable soil 'of thousands of years has been washed from the mountains, 'and after it the mineral soil, hindering agriculture, raising 'the beds of the rivers, and exposing the plains and valleys to 'floods. A striking example of the results of disforestment is 'found in the *Kurische Nehrung*, a zone of littoral sand dunes '60 miles long near the Russian frontier (Courland) between 'Memel and Königsberg, which divides the Baltic from the great 'lagoon called the "Kurisher Haf." This region has now be-'come completely desert, and the hindrance to navigation is such 'that it will be necessary to go on spending for more than a 'hundred years sums whose interest alone is annually more than 'the whole value of the forests destroyed."

The same thing has happened in the Alps, in the Pyrenees at the Combe de Péguère, &c. The chapters on departmental organisation have no particular interest for us at present, but the principles taught in sylviculture and working plans concern us nearly. The Forest School at Eberswald is very complete and well provided for, possessing a park, nurseries, and even a piscicul-ture branch. For practical work it has the entire management of four forest blocks totalling 18,000 hectares (45,000 acres, over 74 sq. miles).

"The Prussian Forest Administration formally rejects the 'theory of those who consider that the object of treatment should 'be the production of the greatest possible *net* * revenue in

* The Bodenreinertrag, or net revenue of the soil, is what remains after deduction of all expenses, and of the *interest on the capital engaged.*

'money, and who go in largely for compound interest tables. On 'the contrary, it holds that the State differs from the private 'owner, in having an essential duty to perform, namely, to direct 'the treatment of the public forests with a sole and strict eye to 'the greatest public good not only with regard to forest produce, 'but also regarding the indirect effects and looking at the subject in 'its widest and most general application. The forests should 'neither be made an object of financial juggling, nor even regarded 'as a capital sum expected to bring in a certain rate of interest. 'They are a trust, deposited in our hands for good management 'during our generation. The usufruct indeed is ours, to the fullest 'extent but we have no right, either to take more than the usufruct, 'or, to alter the constitution of the property ; that is to say, we 'are entrusted, not with a certain sum working at a certain rate, 'but with *forests*, FORESTS and nothing else, and let us look to 'it that our successors find them in at least as good a state as we 'did."

The Prussian administration thus rejects absolutely the commercial exploitability for State forests. Will it be accused, like the late Mr. A'Arcy, of pure sentimentalism ?

The forests are worked at a long rotation. Assuming age-classes of 20 years interval, it is seen that in State forests the trees of 80 to 100 years and over only cover 13% of the area, and that therefore the stock corresponds nearly to an exploitable age of 100 years. The greater part of the pine forests being worked at a rotation of 120 years, and the oak forests at 160 years, it follows that the material as a whole is insufficient.

"For some years past, there has been a marked tendency 'towards the simplification of working plans, especially in pine 'forests. The tendency is to work more by area, allotting a given 'block to a given period, without paying too much attention to 'a distant and problematical increment-expectation. After ab-'straction of blanks, the reduced area divided by the number of 'periods gives the average area of the periodic block. The first 'block contains crops which may, for one reason or another, not 'be prospering, together with a sufficient area of the older crops 'to make up the amount required. Very rarely does the first 'block contain more than the normal, and then only because the 'older crops happen to be distinctly in excess. If any fellings are 'necessary in the other blocks, the volume of trees so felled is 'ascertained, and an area carrying that volume of trees when ex-'ploitable is excuded from the first block. Pursuant to this system 'of simplification, all estimations of volume beyond the first 'period of 20 years are dispensed with."

Reading the above, one seems to be back in the lecture theatre at Nancy, where this very procedure was taught many years ago. The possibility, even for intermediate fellings, is always expressed in c. m. The increment is allowed for at a moderate rate.

The Palmyra Palm.

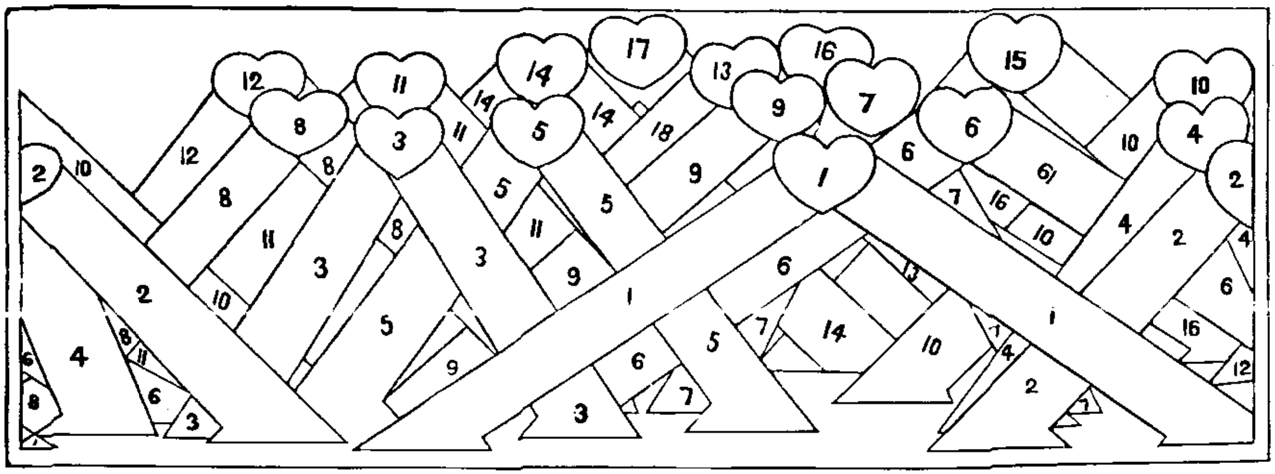

Diagram showing part of the circumference of a Palmyra tree rolled out. Leaves cut off just above the sheath of the petiole. Sheath broken in all cases.

Scale 1″ = 4″.

The regeneration of the pine is generally sought artificially, by planting in most cases, after a clean felling. But on the sands the young plants are often destroyed by cockchafer larvæ, and the Prussian foresters have an embarrassing choice between this difficulty and that of natural reproduction by seed. In the Eastern provinces, where the pine will bear a little cover, they have adopted the method of groups or wells, freeing any patches of seedlings that may arise under the cover, and progressively enlarging the patches as seedlings appear on the borders. In this case it is generelly necessary to regenerate two blocks at once ($\frac{1}{3}$rd of the area with a rotation of 120 years) or even over larger areas, which approximates the system to that of jardinage. Nevertheless, it cannot be said that natural reproduction is difficult in a country that has millons of hectares of pine, and the German foresters will surely find out the secret. At present they are seeking a method of small coupes which may lead them to the possibility by area. In pine forests this would be so simple, so clear, and self-evident, that it is astonishing to find the best foresters of Europe still entangled in volumetric calculations. Will the Americans have to come to the rescue ? They are not the people to go playing around, measuring every tree from Florida to Vancouver with a shoemaker's measure, not even though perfected by Edison. Some day—who shall say how soon—the possibility by area may return to us from America, as pippins from Canada.

CH. BROILLIARD.

(Translated freely from the "Revue des Eaux et Forêts" by F. G.)

IV.—REVIEWS.

Review of Forest Administration in British India for the year 1894-95 by B. Ribbentrop, C. I. E., Inspector-General of Forests.

In accordance with our usual practice we *propose to give a brief account* of this interesting Review with selections of the most important portions of it.

Area.—During the year 1570 square miles were added to the Reserved Forests of the Bengal Presidency, 694 square miles in Madras and 675 square miles in Bombay. There were 257 square miles of exclusions, so that the total at the end of the year came to 74,271 square miles. The protected forests aggregated 7090 square miles and unclassed forests 31,591 making the total of all classes under the Department 112,952 square miles. Settlement is going on well and is said to be approaching completion in some provinces, while in others, notably Madras, it will take 5 or 6 more years.

Demarcation.—A detailed form gives the details of the progress of this work, the net result of which for the Bengal Presidency is that 44,889 miles of boundary lines are now demarcated while 5741 miles still remain to be done.

Surveys.—A map is given on which are shewn in red the areas for which Survey is completed and in green those which still remain to be done. Four parties of the Survey of India were at work as well as the Forest Survey Branch. Altogether Rs. 1,19,169 were spent by the meet Survey Branch and Rs. 3,69,419 by the Survey of India.

Working Plans.—On this subject, we shall do best to quote the following remarks of the Inspector-General of Forests :—

"During the year ten working-plans, dealing with an area 'of 1,760 square miles, were sanctioned, and the area under re- 'gular systematized working stood at 9,423 square miles, or 12 'per cent. of the forest area, at the close of the year. Large areas 'remain to be dealt with, especially in Bengal, Punjab, the Cen- 'tral Provinces, Upper Burma, and Assam. A considerable pro- 'portion of these areas consist of forests in which, owing to the 'absence of markets, the production is far in excess of the demand, 'and in such cases the preparation of working-plans, though 'desirable, is not a work of immediate necessity. On the other 'hand wherever there is a steady demand, and more especially 'where this approaches the production of the forests, the introduc- 'tion of plans of working defining the main objects with which 'the estates are to be worked and the amounts of forest produce 'which can safely be utilized is of the greatest importance.'

"With regard to the control of existing working-plans, it may 'be said that year by year as what is required becomes better 'understood, the plans prepared become clearer and more practical 'in their provisions, and that more and more attention and care is 'exercised in carrying them out. During the year under review, 'generally speaking, the provisions of existing plans were well 'carried out. When deviations occurred through force of circum- 'stances, these were reported to, and sanctioned by, the Local 'Government concerned. It may here be noticed that as the num- 'ber of plans increases—and this is taking place with rapidity—the 'work of controlling them becomes more laborious ; and the time 'will sooner or later arise when the control of working must be 'placed more directly in the hands of Conservators."

Communications and Buildings—On this important subject the Inspector-General makes the following remarks :

"Considerable activity was displayed on the construction and 'maintenance of export roads connecting the forests with the 'markets they supply. In some provinces it was found necessary 'to construct roads outside the forests. In the Bengal Presidency 'Rs. 55,677 were spent on new roads, and Rs. 76,021 on repairs. 'In Madras Rs. 32,007 and in Bombay Rs. 2,918 were spent on 'road work. The highest expenditure (Rs. 64,721) took place in 'the North-Western Provinces and Oudh, where an excellent sys- 'tem of roads exists, without which the produce of the forests would 'be unsaleable."

"It is to be observed also that the construction of railways near 'or through the forests has in some instances considerably increased 'the demand for forest produce of all, and more particularly of 'inferior, kinds. Good sound timber of large dimensions general- 'ly commands a ready sale. But the supply of such is but limited, 'and in the case of most of our forests, owing to the want of easy 'communication with the markets and the consequent cost of ex- 'traction, the mass of timber of inferior quality or species, as well

'of minor forest produce remains unsold. The construction of 'railways, such as that through the Oudh forests and that of the 'projected lines from Nazibabad to Kotedwar will assuredly tend 'to the development of trade in such products."

"Attention was also directed, particularly in the North-West-'ern Provinces and in Madras, to the construction of rest-houses, 'and to providing suitable accommodation for Range officers and 'subordinates. In the Bengal Presidency Rs. 1,11,660 were spent 'on new building work, and Rs. 51,692 on repairs. In Madras 'Rs. 34,143 and in Bombay Rs. 17,802 were spent on building 'work."

At first sight it might seem as if this was a large sum, but in reality it is very small, amounting only to 3·4 Rs. per square mile of forest under management. If the supply which our forests are capable of yielding is to be made fully available for the use of the country, much more than this must be spent in roads for export and in the proper housing of subordinates. The latter is a matter of great importance, for we hold that in order to obtain an efficient and honest staff of good education, they must be properly housed and properly treated.

Fire-protection.—We are glad to see that Mr. Ribbentrop realizes that any comparison between cost-rates is of very little use when the circumstances of different Circles, different Divisions and even different pieces of forest are so varied as to make such a comparison most difficult and the conclusions drawn from it often most misleading. He says :—

"Even though allowance were made for the variations in the 'labour-rates in the various provinces, the difference in the con-'ditions affecting fire conservancy are too great and manifold to 'permit of any useful comparison between the cost-rates. We 'have to do with grass-fires, with bush and with leaf-fires, and to 'meet endless varieties under each class. For instance, as regards 'grass-fires, circumstances may require the early cutting of broad 'traces through belts of dense grasses in which an elephant cannot 'be seen, and of burning the dry grass thereon before the adjacent 'jungle is inflammable. Narrow traces are of no use in such 'localities, as the fire, coming from the outside, would cross them. 'It is evident that operations of this kind, in order to be effective, 'cause a large amount of labour and a considerable outlay, whereas 'in other localities the grass may only be a few inches high, 'and here the outward firing may be controlled with the greatest 'ease by cutting a path a few feet broad, and in some cases even 'this is not required. Between these two extremes numerous 'variations exist, requiring more or less expensive measures in 'order to isolate the forest to be protected. Again, as regards 'leaf-fires, all depends on the time and manner in which the 'various forests shed their leaves. In some cases this happens 'before the fire-season commences and a single sweeping and

'burning of fire-traces suffices to protect the forests, whereas in 'others the shedding of leaves continues all through the driest 'weather and renders necessary a continuous attention to the 'clearing of the fire-trace. Thus, for instance, a fire-trace through 'a *Pinus longifolia* forest is entirely intractable, and forests of 'this character can only be protected by the sacrifice of a broad 'belt on which all growth of the species is prevented, thereby 'changing the character from a leaf-fire to a grass-fire protection. 'In how far the adoption of this measure is advisable in deciduous 'forests depends entirely on local conditions, and cases have 'occurred, where the cutting of a broad belt through the natural 'forest was followed by a grass-crop so dense and high as to 'render fire-protection more laborious and costly than it was be-'fore. The character of the surrounding country also greatly 'influences the difficulty and cost of fire-protection."

"It will be seen from the table at the beginning of this sec-'tion that out of 30,963 square miles, the special protection of 'which was attempted, 28,913 were saved and 2,050 square miles 'were overrun by fire."

In regard to the forest fires in the Punjab, the Inspector-General quotes from the Government of India Review of the year's report as follows, but whether the authorities of the Province will take any action in the matter remains to be seen.

"The attempts at fire-protection were even less successful 'than in previous years, there having been a marked increase in 'the areas burnt over in all but the Chenab, Chamba and Umballa 'divisions. It is observed with special regret that the grazing 'concessions which were given in the Hazara division in order to 'obtain the good-will of the people, were immediately followed by 'the burning of the opened area, with the alleged object of obtain-'ing fresh grass. The Government of India hope that every effort 'will be made to impress upon the people the scope and object of 'the concessions, and that they will be withdrawn without fail in 'regard to all areas burnt. It is noted with concern that a great 'proportion of the fires took place in specially protected areas. 'The continued failure to protect the forests from fire so seriously 'affects the permanent well-being of the country, that the Govern-'ment of India agree with the Lieutenant-Governor that where 'wilful burning is proved, whether with intent to do damage or 'in order to obtain new grass, the punishment should be exemp-'lary and deterrent."

We have already commented in this magazine on the question of fire in the Burma teak forests, so need say nothing more now.

Grazing.—This subject is rather fully discussed and it is pointed out that the idea that forest conservancy should, as far as possible, be restricted to remote regions for the growth of timber (surely 'of gigantic trees' can only be slightly sarcastic !) has been gradually abandoned and consequently the mass of the forest

areas are expected to supply not only wood material but also a certain amount of grazing. The discussion is too long for quotation, so we need only refer our readers to the report itself.

Reproduction.—We cannot do better than quote at length the long and interesting account of reproduction in the various classes of Indian forests which Mr. Ribbentrop has drawn up.

"The principles of sylviculture are the same all over the world 'but their application varies according to circumstances and con-'ditions, and in this respect every conceivable variety is represented 'and has to be dealt with in India. The extent of the forest areas 'and the comparatively small income per acre necessitates, in most 'cases, a sylvicultural treatment solely based on natural reproduc-'tion, and the questions involved require the Forest officer's con-'stant study and thought. It is true that in the majority of our 'forests, especially in those which are the more valuable ones from 'a purely fiscal point of view, natural reproduction advances satis-'factorily under a continuous protection from fire and cattle, but 'this alone is barely sufficient for the maintenance and improvement '*of the character of the* crops, as the species composing the *peuple-'ment* in Indian forests vary in value to a much greater extent than 'is the case in Europe for instance."

"In the gregarious pine forests in the North-West Himalayas, 'it is the deodar to which the preference must be given in all suit-'able localities. Its value is twice that of any other pine, and in 'many cases it is the only species which can as yet be profitably 'extracted. The treatment of these forests offers, consequently, 'considerable difficulties, especially in localities which, on account 'of their position, exposure and soil, are more favourable to inferior 'species. Good progress has, however, been made in the study of 'this class of forests and their reproduction, and working-plan pre-'scriptions for their treatment now rest on a comparatively safe 'basis. It has often been found necessary to assist the natural re-'production of the deodar by cultural operations, planting or the 'dibbling in of seed on prepared plots or lines, and by the felling 'or girdling of inferior pines in advance growth of the better 'species. These operations are now fully understood, not merely 'by *the supervising ranger and forester, but by the* work-people, 'and success almost invariably attends their execution."

"The sal forests in the Sub-Himalayan tracts in the 'Garo Hills, and in the belt extending from the Bay of 'Bengal to the Vindhya Range form another class of more 'or less gregarious forests, in which reproduction is, as a rule, 'sufficiently abundant wherever an efficient fire-protection has 'been secured and grazing has been regulated and restricted. 'At the outset of regular forest management, the prevalence of frost 'in exploited localities often caused great anxiety and trouble. In 'others it was the rapid growth of high grasses which interfered 'with reproduction, and on clayey soils the dense crop of a young

'growth of *Terminalia tomentosa*—a tree by no means unmarket-'able, but of less value than sal. Here again, however, it may be 'asserted that the study of the characteristics of this class of forests 'and their behaviour towards the dangers which mainly threaten 'their satisfactory reproduction has sufficiently advanced to secure 'a fairly correct and generally successful treatment."

"The areas of deciduous forests which cover the greatest part 'of the country, from the southern slopes of the Himalayas to Cape 'Comorin, as well as in Burma, may for our purpose of reviewing 'the value of reproduction, be divided into two main classes :—

(*a*) Those which contain the teak, the padouk, the cutch, the ironwood, the red sanders, and sandal and any other of those trees, which, on account special qualities, command a sale beyond the local market and exceptional prices, and in which the application of sylvicultural principles is consequently mainly directed towards increasing the proportion of the more valuable species in the crops of the future.

(*b*) Those forests which are situated outside or near the margin of the habitat of such trees, and in which species are absent, or sparsely represented. In such forests, which are treated for the local supply of timber and firewood only, no pronounced measures are required in favour of any particular species, though of course even here one or several kinds of trees are usually more valuable and useful than others, and their reproduction is naturally favoured by retaining them as parent trees for the new crops.

"Amongst the deciduous forests of class (a), those containing 'the teak are the most important, not merely of this class but of all 'forests in India. They have frequently an additional value owing to 'the presence of cutch, ironwood, padouk and other valuable species. 'Their reproduction and improvement offers an inexhaustible study 'to the forester, and has probably received more attention in this 'respect than any other class of forests. Pure teak forests, and 'even such in which the teak forms the main part of the crop, are 'rare, especially in the eastern and more more important zone of 'the tree, and are found only in specially favourable localities. In 'forests of this character reproduction presents no difficulties, a 'judicious exploitation and protection are all that is needed to en-'sure favourable results. Where, however, the teak tree is found 'intermixed with other species, and, as is often the case, forms only 'a small percentage of the mature crop, the chances of reproduction 'of the more valuable species are lessened with every mature teak 'tree which is removed. In such forests favourable results have 'been frequently achieved by girdling trees of the inferior classes 'round or in the vicinity of teak seed-bearers, thus producing an 'advance growth of the superior species before the mature stems are 'removed. All natural advance growth of teak is in such localities

'fostered even at the sacrifice of mature trees of less value, and 'though such interference may be of limited extent only in each 'case, the aggregate of the forests improved in this manner repre- 'sents a large and important area."

"The existence of a bamboo forest beneath the canopy of the 'tree-crop renders the natural reproduction of teak a question of 'special difficulty. The forests in which this difficulty exists are 'very extensive and in the eastern zone cover by far the largest por- 'tion of the teak areas. These bamboo forests vary in character in 'accordance with soil and situation, from the light cover of *Dendro- 'calamus strictus* to the dense shade of *Bambusa polymorpha* and '*Cephalostachyum pergracile*. The former species, which flowers 'sporadically as well as gregariously, does not entirely prevent the 'natural reproduction of tree growth, and in forests with an under- 'growth of this character, representatives of teak of all age-classes 'are usually found frequently accompanied by cutch. The dense 'cover, however, of the periodically and gregariously flowering 'bamboos renders natural reproduction of teak almost impossible, 'except during such periods of flowering. This fact accounts for the 'existence of tree-crops separated in age by the length of these 'periods. It is useless, in respect of these forests, to speculate and 'report annually on the progress made in natural tree reproduction, 'as a consequence of fire-protection, which only tends to make the 'shade denser and more prohibitive towards the growth of seedlings. 'In forests of this kind all measures must be and are preparatory to 'the next occurrence of a general flowering, and thus the value of 'fire-protection is great as one of the means of securing healthy 'parent trees."

"The prescriptions of all working-plans and the girdling pro- 'posals framed under their provisions, tend in the same direction in 'preserving a sufficiency of seed-bearers. A special feature in the 'treatment of these forests is the formation of teak *taungya* planta- 'tions.* These are scattered about in localities where, though

* I have recently been asked what a teak *taungya* is, and take this opportunity of explaining how the destructive method of shifting cultivation, in vogue amongst nearly all uncivilized tribes, has been utilized for arboricultural purposes. The areas on which these people are permitted to cultivate are selected by Forest officers within the boundaries of fire-protected reserves, the places chosen being those in which valuable species are absent, or but sparsely represented. All forest growth on these areas is then felled and when dry is burnt, due care being taken to prevent the fire from spreading into the surrounding forests. The ground is cultivated in the beginning of the rains, and the agricultural crop is interplanted at such distance as may be fixed, usually 6′ by 6′, with teak, cutch, or such other species as it may be desirable to establish. At the beginning of the second year a certain fixed rate is paid for every 100 well established plants. This method of tree-planting was first introduced in Burma, where the areas brought under shifting cultivation are called "taungyas" If utilized for the cultivation of teak they were called teak *taungyas*, if for cutch, cutch *taungyas*. As the name is well established in the province where the method originated and has been used in some other provinces, it would seem advisable to apply it to all India instead of using the numerous local names, and to accept the expression "arbori-taungya" for all cultural operations of this kind.

situated within the natural habitat of the tree, the species is sparsely represented; and will, when a flowering of bamboos takes place, it is hoped, form so many centres from which the teak will naturally spread to other portions of the forest. These *taungya* 'plantations have in addition a considerable intrinsic value as timber-producing areas, for they already extend in Burma over '35,644 acres, and are the result of little more than twenty years' 'work. Some 2,000 acres a year have been added of late, and during the year under review the area was increased by 3,903 acres. 'Other cultural operation in bamboo forests such as the planting up 'of strips, were undertaken with the same purpose of establishing 'belts or plots of parent trees. In many instances such operations 'have shown excellent results, but mostly at a cost which seems 'prohibitive if compared with *taungya* cultivation."

"Insufficient advantage was taken during the first year of the 'gregarious flowering of myinwa (*Dendrocalamus strictus*) which 'took place in the Bawbin and Toungnyo reserves in Lower Burma 'in 1893-94, but experience shows that useful arboricultural operations may be undertaken, amongst this species at least, for a considerable number of years, subsequent to its seeding and before 'the new cover is fully re-established."

"A general flowering of kya-thaungwa (*bambusa polymorpha*) is 'to take place in Burma within the next few years, and as the fully 'grown forest of this species prohibited tree reproduction of any 'kind, systematic preparations, in order to take full advantage of 'the expected opportunity, are under consideration. It is believed 'that this species of bamboo, like some of the other gregariously 'flowering kinds, will send out no fresh shoots in the year previous 'to seeding, and thus give a timely warning. It is also probable 'that its clumps will die without seeding if felled just before it 'flowers, and that a clear field may thus be obtained for the growth 'of teak seed. The operations which will follow the actual seeding, 'and perhaps even the first cultural treatment indicated, will probably necessitate the extensive use of fire, and this is a delicate 'procedure which cannot be extended beyond manageable limits, 'as it is essential that the fires should as far as possible, be retained 'in the areas operated upon, and that once cultivated, they should 'be scrupulously protected."

"Soms time ago it was asserted by botanical authorities that 'the continued cutting of the young bamboo shoots would weaken 'the parent clump to such an extent that it would probably die 'within three years. It was with good grounds believed that if this 'assertion proved to be correct, the difficulty of naturally reproducing teak forests with an undergrowth of *Bambusa polymorpha* at 'all times, and not merely for a few short years during the seeding 'of the bamboos, would have been solved, and experiments in this 'direction have been continuously carried on in several divisions in 'Burma for the last four years. The results of these experiments 'are as yet inconclusive. They have, it seems, proved that the

'removal of the young shoots year after year does not lead to the 'death of the parent clump, or to any great apparent loss in its 'vigour; but it was nevertheless found that the amount of shade 'cast on the ground had been materially lessened in consequence of 'these operations. Under these circumstances it seems advisable 'that the experiments should be continued for some years at least 'and that the efforts to reduce the vitality of the bamboos might be 'assisted by the removal of the mature stems as well on the experi-'mental areas. The point in question, *viz.* the natural reproduction 'of teak independently of the flowering of bamboos, is of sufficient 'importance to warrant any trouble and expense in its satisfactory 'solution, and in case the annual cutting of the new shoots, if car-'ried out in addition to a heavy working of the mature crop, would 'remove the difficulty, practical effect, on a considerable scale, 'could be given to this scheme by a system of free licenses granted 'with the condition that the new shoots of the year should be cut 'at the same time. The removal of new shoots during subsequent 'years would be a cheap operation."

"The Madras report, which contains an excellent *resumé* of 'reproduction, shows that a fair reproduction of teak, ironwood and '*Terminalia tomentosa* attended the gregarious flowering of bamboos 'on the Godavery river. Experiments made in the introduction of 'arbori-taungya cultivation in North Malabar have also met with 'success, and might probably with advantage be extended to other 'parts of the country, especially to South Canara, where the paucity 'of parent trees of the more valuable kinds is reported to be the 'chief reason for the absence of seedings of these species. The 'good results obtained with teak taungya cultivation in Coorg is 'also worthy of note."

"The natural reproduction, especially of teak, in the north-'western teak zone, including principal centres of the tree (the 'Panch Mahals in the Bombay Presidency, the Melghat in the 'Berars and the Ahiri forest in the south of the Central Provinces) 'has been reported as satisfactory throughout, where fires have been 'excluded. In the Panch Mahals, which are specially favourably 'situated for export to large local markets, this problem has not as 'yet been solved satisfactorily, and the young crop has as yet been 'cut down and decimated year after year over the greater part of 'the area. Dense bamboos crops do not interfere with natural repro-'duction in this zone; to the same extent as in Burma, nor are 'the varieties of other less valuable trees so plentiful as in that 'country."

"The natural reproduction of cutch is, except on the limits of 'its habitat, very satisfactory. In Burma, where, owing to the 'great development of the cutch industry, the tree is of special 'value, its reproduction is assisted by means of *taungyas*, consider-'able areas of which are cultivated year after year with great 'success."

"The natural reproduction of ironwood (*Xylia dolabriformis*), 'is, even more than that of teak and cutch, dependent on strict fire

'protection; for, though the tree is a very free seeder, few of its 'seedlings survive even the slightest leaf-fire. In the Rangoon 'Division in Burma where the tree was extensively exploited, dur'ing the construction of the railways, previous to fire-protection 'having been extended to the forests whence it was extracted, con'siderable areas have been more or less denuded of this valuable 'species."

"A more careful examination of the deciduous forests in the 'Andamans has proved the existence of satisfactory natural repro'duction of the padouk tree."

"The deciduous forests of the (*b*) class are to a great extent 'treated for more or less local markets, which as yet do not, as a 'rule, demand timber of large sizes in any great quantity, and the 'prescription of systematic plans for their treatment rely to a great 'extent on reproduction by coppice. The main principle applied 'to forests of this class is one of improvement in fellings, which 'frequently, as, for instance, in the Thana District in the 'Bombay Presidency and in many parts of the Central Provinces, 'assumes the features of a coppice under standards. The coppicing 'power of most of the species composing these forests has proved 'to be considerable, and reproduction from these operations have 'generally been fairly successful. A permanent maintenance of the 'forests cannot, however, be relied upon from coppice shoots only, 'and in some localities, as evinced in the working-plan of the 'Godhra Mahal forest in the Bombay Presidency, for instance, it 'has already been found that some of the most valuable species 'refuse to coppice any longer. It is under these circumstances of 'great importance that a good crop of seedlings is in most cases 'found mixed with the coppice crop, as the result of the operations 'by which, according to circumstances, a larger, or smaller propor'tion of the healthiest parent trees are left on the ground. Where 'the crop of seedlings is insufficient and where the forests of this 'class are, owing to a large demand, of special value, the natural 'reproduction has been assisted by dibbling operations and even by 'planting. Special energy has in this respect been displayed for 'many years in several of the districts of the Bombay Presidency 'where cultural operations have been systematically carried out by 'the agency of forest guards at very little cost to the State. It is 'hardly possible to gauge the influence such operations may have 'had, but as a considerable admixture of seedlings in the forests, 'thus treated, is reported to exist, it may be assumed that this is, 'to a great extent, due to the continuous and energetic system of 'dibblings adopted."

"The coppicing power of the various trees and its maintenance 'has as yet been incompletely studied, and the work in this respect, 'even under preconsidered plans, contains therefore a considerable 'element of uncertainty, which careful observations, records and 'time alone can eliminate."

"Generally speaking, it may be said that reproduction in the 'deciduous forests has made good progress in all areas to which

'protection against fire and grazing could be extended, and that, 'though many and important questions remain as yet unsolved, 'considerable advance has seen made in their rational treatment, 'and the consequent improvement in the character of the new 'growth. The deciduous forests pass into dry forest areas in which, 'owing to the limited rainfall, the forest flora is a poor one, and the 'individual trees are badly developed. Within these areas the dif-'ficulties regarding fire-protection diminish considerably, but re-'production without the strictest closure becomes more and more 'uncertain. The question how the dry forests in the Punjab *bars* 'came into existence, and how they reproduce themselves apart 'from coppice in any but exceptional favourably situated localities, 'is as yet by no means solved."

"A sprinkling of seedlings is said to have been noticed in the 'Multan *rakhs*, but the process of reproduction from seed is so slow 'that a very long period of strict closure would be required to 'ensure the re-stocking of the forest in this way, and the results 'would probably be quite out of proportion to the value of the grass 'crops which would have to be sacrificed in the meantime. Luckily 'the coppicing power of the long-rooted species which constitute 'these forests is wonderful. Centuries seem to have made no differ-'ence, but during that time these areas had not to supply fuel for a 'constantly increasing network of railways, and the continuity of 'their vigour of coppicing under these changed circumstances is 'by no means a certainty."

"Observations made of late years in Baluchistan show that the 'conditions of natural reproduction of the juniper forest in that 'country are more favourable than they were previously supposed 'to be. This is fortunate, as the water available for irrigation is so 'scarce and valuable that the establishment of extensive artificial 'plantations had to be abandoned."

"Of the fringes of arbori-vegetation found on the banks of 'rivers, those on the Indus and its tributaries on their courses 'through the plains are, owing to their situation in a dry zone, the 'most important. Natural reproduction on *sailaba* lands, where 'the trees are nourished by perennial percolation from the streams, 'and on the large riparian areas, subject to inundation during the 'hottest months, is as a rule plentiful and satisfactory. On the 'former lands the natural original establishment of forests is fre-'quently a long and tedious process, but where they have been 'artificially constituted, as for instance in Shahdera near Lahore, 'they yield a considerable outturn and readily reproduce them-'selves both from seed and coppice."

"Reproduction on the inundated areas in Sindh is reported to 'have been seriously curtailed by the construction of dams, which, 'it is asserted, considerably reduced the area formerly inundated, 'and exposed others to exceptionally high floods which prevented 'reproduction by a deposit of silt. This may be the case, but there

'seems no doubt that new forest areas will constitute themselves 'outside the system of embankments."

"The reproduction of littoral forests, of which the Sundarbans 'is the most valuable representative, is always profuse, so long as 'the area is not raised above tide level which is a very gradual 'process and presumably accompanied by the same gradual addition 'of land elsewhere. In the Sundarbans, the sundri, the most 'valuable constituent of the forests, seeded abundantly and 77,000 'seedlings, 18 inches high, were counted to the acre on the Ban- 'gasal island."

"Reproduction in evergreen forests has been generally report- 'ed as plentiful and satisfactory in character, but these forests 'have nowhere as yet been extensively worked, and great difficul- 'ties will no doubt be encountered, where this happens on account 'of the very luxuriance of vegetation, which it will be difficult to 'guide in the direction most desired."

' The caoutchouc-yielding *Fici* grow mostly outside the sphere 'of safe observation in forest inhabited by more or less savage 'tribes and little is known as regards their reproduction.

Outturn.—The following are the figures of the total outturn of timber, fuel, bamboos and minor produce from the forests of the different Provinces for the year 1894-95 :—

	Government.	*Purchasers.*
	CUBIC FEET.	
Timber ...	... 5,727,264	39,923,591
Fuel ...	... 28,056,761	68,967,654
	No.	
Bamboos	... 1,616,237	132,196,511
	Rs.	
Minor Produce	... 1,88,654	30,25,197

It is explained that collections by Government agency are gradually giving way to export by the purchasers themselves.

Finance.—Here we notice that the figures for the "financial" year are given instead of those for the "forest" year. We can easily understand that the figures which are given in the Budget reports are these which it is most convenient to use, and perhaps if this is admitted the arrangement of a "forest" year may now be given up as a failure. The *gross* revenue of the year was Rs. 167,88,880 and the *net* revenue Rs. 74,15,590 which is 44 per cent. of the *gross*, and Rs. 65 per square mile of land under forest control.

For the first time, a statement is given of the value of the forest produce which is given free or of the loss by reduced rates

to right-holders and grantees. It amounts to the following :

		Rs.
Timber ...	..	... 7,86,013
Fuel	...	... 23,84,208
Bamboos ...	...	... 2,12,472
Minor Produce ...	...	... 9,35,461
Grass and Grazing	...	... 16,30,651
	Total	... 59,48,805

By rights, this sum should be added to the revenue of the year to show the true results of the work, which would come to Rs. 227,37,685 *gross* and Rs. 133,64,395 net. A Department which gives away free as much as $44\frac{1}{2}$ per cent. of the net income cannot *be said to be quite so grasping and greedy as it is* sometimes accused of being by those who do not or do not wish to know the facts.

Education.—The following remarks on the question of providing employment for the passed students of English extraction from the Dehra Dun Forest School will be read with interest.

" A considerable number of Extra-Assistant Conservatorships ' have been created since 1891 under the reorganization of the ' department, and many of these appointments have been obtained ' by students who passed out through the Dehra School previous ' to 1893, who thus have gained fair prospects of further promo- ' tion in the Provincial Service. The result of this early promo- ' tion of a few officers who had the luck to enter the service at the ' right time has caused a continuous influx to the school of lads ' of English extraction and habits ; and the fact that the Provin- ' cial cadre when once filled can only be entered after a prolonged ' service in the Ranger class on a pay rising from Rs. 50 to Rs. 150 ' per mensem seems to be lost sight of by the parents and guar- ' dians of the young men competing for entrance into the Dehra ' College."

" The pressure is already beginning to make itself felt, and ' most of the Provincial lists contain a number of young men of ' English extraction on a pay of Rs. 50 to Rs. 80, which is entirely ' insufficient to support them in the manner in which they have ' been brought up. The recent reorganization in Burma will oc- ' casion once more a certain relief in the pressure from below, and ' there is some prospect of the Siam Government indenting on ' India for some of its trained foresters of English birth. The re- ' organization of the Subordinate Service which is so much needed ' for a sound administration will also, when sanctioned, consider- ' ably improve the existing prospects ; for the scheme, as promul- ' gated, provides at least for a proper gradation in the Ranger's ' class, and for a fair proportion of appointments on Rs. 125 and

'Rs. 150. The fact, however, that the service, even after such 'reorganization has taken place, begins, as a rule, on a pay of 'Rs. 50 and may, when fully organized, eventually necessitate the 'gradual working up through all grades of the Ranger's class 'until the Provincial Service can be entered, would hardly seem 'to render it particularly suitable for lads of English extraction 'No doubt a certain amount of selection will always govern the 'promotion from the Rangers class into the Provincial Service, 'and superior energy in the Subordinate Staff will always be 'rewarded in this way ; but there are many trained Rangers of 'pure Native extraction who yield nothing in this respect to any 'one, and with whom the young Englishman has to compete on 'equal terms. The influx of European students to the Dehra 'School has to some extent been encouraged by the frequency 'with which the maximum stipends were sanctioned by Local 'Governments to students of this class, who thereby became at an 'early age more or less independent of support from their parents. 'It was moreover concluded that the grant of such stipends placed 'the Government under the obligation to provide employment for 'the stipendiary students so long as they obtained a pass certifi-'cate, and this belief was no doubt fostered by the previous action 'of the various Forest Administrations. In future the grant of 'such stipends will be considerably curtailed, especially as regards 'students of European extraction."

We are glad to see at the end of Mr. Ribbentrop's Report, some remarks on the forest work done in the Native States. We are surprised to see Travancore, where such excellent work has been done, omitted ; and we believe there are other States especially in Bombay (*e.g.*, Kolhapur) which might have come in for some remark. On the other hand, so far as we know, the work in Nahan has so far been rather a sham, but with the appointment of an experienced European Conservator a change may be expected. Another year, also, perhaps, the Inspector-General might tell us what is being done in different Provinces in zamindari estates and especially in those under the Court of Wards. The following are his remarks on the subject :—

"Copies of their Forest Administration Reports have been 'received by the Government of India from Mysore, Kashmir, 'Jeypore and Jodhpur. In Mysore and Kashmir, with a net for-'est revenue of Rs. 9,20,000 and Rs. 3,39,000, respectively, forest 'administration is, so far as can be judged from the reports, con-'ducted much on the same lines as in British Provinces, and pro-'gress, especially in the selection and settlement of State forests 'and their permanent demarcation, is well maintained."

"The forest property in both these States is extremely valu-'able, and the steps now taken in securing its permanency are of 'the greatest importance. Considerable attention is paid to the 'protection of the forest areas, especially from fire, but though the 'chapters dealing with exploitation are very full and detailed, no

'mention is made in either of the reports of any progress made 'towards gauging the permanent possibility of the forests, and it 'is not shown whether the exploitation is in any way systematized 'on the basis of either material or area. Forest administration in 'the Jeypore and Jodhpur States is on a much smaller scale, but 'the progress reported seems, generally speaking, to be satisfac-'tory. As regards the Jeypore report it is extremely difficult to 'reconcile Forms Nos. 54 and 55, from which it would appear that 'on 29,000 acres open to browsers, 1,32,341 goats and sheep and '2,502 camels had been permitted to graze either free or on pay-'ment, or nearly five animals per acre, not including cattle of 'other descriptions."

"Forest conservancy, more or less systematically carried out is, 'however, by no means confined to these four States, which issue 'printed Administration Reports. There are many of the larger 'States, such as Nahan for instance, where this branch of the 'administration is fairly well organized. In Patiala also many 'forest areas are systematically worked, and a considerable number 'of the smaller States follow this example, in organizing their 'forest management."

VI.—EXTRACTS, NOTES & QUERIES.

Forest Reservation in the United States.

As we go to Press the announcement is made that President Cleveland has set apart by proclamation thirteen new forest reserves, including altogether an area of more than twenty-one million acres. This, added to the reservations previously established by Presidents Harrison and Cleveland, increases the total area of reserved forest land in the Western States and territories to about thirty-nine million acres; that is, the combined area of these reservations, exclusive of the National Parks, is as great as that of the States of Maine, New Hampshire, Vermont, Massachusetts and Rhode Island. The new reserves include all the central portion of the Black Hills of South Dakota, the Big Horn Mountain Range in Wyoming, the Jackson Lake country south of the Yellowstone National Park, in Wyoming, all the Rocky Mountains of Northern Montana, a valuable forest region in Northern Idaho, the principal part of the Bitter Root Mountain region in Montana and Idaho, the Cascade Mountains of Northern and of Southern Washington, the Sierra summits of California north of the Yosemite National Park, the San Jacinta Mountains in Southern California, and the

Unitah Mountains in Northern Utah. The location and boundaries of these forest lands have been carefully studied by the Commission appointed by the *National Academy of Sciences*, who have made it their aim to include as much as possible of the great bodies of timber that are left on unentered land, and wherever it was practicable to secure the continued existence of the forests on high mountain slopes which protect the sources of streams most useful for irrigation and navigation. Much remains to be done before this magnificent domain is rendered safe from spoliation, but the simple act of setting these forest lands apart *is enough to justify the creation* of the Commission. In our next issue we shall publish with some fullness of detail a description of the reservations, and we only add here that it may be doubted whether any Act of President Cleveland's adminstration will have such a beneficient and far-reaching influence upon the welfare of the country as this series of proclamations. The country is to be congratulated on having a Chief Magistrate who is capable of taking such a broad and statesmanlike view, and the people will be grateful to him for the promptness and decision with which he has acted.—*Garden and Forest.*

Indian Timbers for Fishing Rods.

We publish below the abstract of a paper, reprinted from the *Fishing Gazette*, on woods at present used for making fishing rods, and on some Indian timbers which might be used as substitutes for these by Surgeon-General G. Bidie, C.I.E., F.Z.S., &c.:—

Everyone knows how largely the serviceable qualities of a fishing rod depend on the kind of wood of which it is made, and it is the subject of the above paper to notice briefly the more important woods at present used by rod makers, and to introduce to notice some Indian timbers which may prove as good as, or even better than, those at present employed. To produce high-class rods, the wood must not only have special natural qualities, but these must, so to speak, be brought out and fixed by long and careful seasoning; moreover, the same log will yield, from different sections, materials of very different value, a fact which necessitates careful testing and the rejection of many inferior pieces. The woods most used at the present time in rod-making are, greenheart, washaba, blue maboe, lancewood, hickory, ash, snakewood, and canes. Of all these, putting aside the canes, the chief favourite is:—

Greenheart, obtained from a laurel, *Nectandra Rodioei*, the Bibiri tree of British Guiana, which attains a height of 60 to 70 ft. The timber is chiefly used for making piles, and in shipbuilding. It is a heavy wood, having a specific gravity of 1, but no

wood at present in use will furnish a more elegant and serviceable rod.

Washaba, which also comes from British Guiana, is very like greenheart, but is heavier and more difficult to work.

Mahoe.—There are several trees to which this name is applied, found in various parts of the tropics. Chiefly used in this country for rod-making is the Blue Mahoe (*Paritium elatum*) of Cuba and Jamaica, a very light, strong, and resilient wood. Its elasticity accounts for its being used in Cuba for springs for a two-wheeled cart called a "Volante." The wood of the Indian Seaside Mahoe or tulip tree (*Thespesia populnea*) is worth a trial by rod makers.

Lancewood, which occurs in Guiana and Cuba, is a wood easily worked, light and elastic, and is used a good deal by carriage builders. Being less heavy than greenheart, it is preferred by some makers for tops for fly rods.

Hickory (the American *Carya alba*), ash (*Fraxinus excelsior*), and snakewood (*Brosimum aubletii*) are less extensively used in this county for rod-making.

The canes chiefly used in the rod industry are: East Indian mottled, Spanish white, South Carolina, and Japanese; also the ordinary male and female bamboo.

In bringing to notice Indian woods likely to make serviceable rods, the difficulty is to make a selection, as the forest flora of India is very rich in valuable timbers, of which but very few are known and utilised either locally in the East, or in the European markets.

Trincomallee wood (*Berrya Ammonilla*) is the wood used in Madras for making the large *masoola* or surf boats, where its strength, elasticity, and toughness, while bumping violently in a heavy surf, are tested in a way that hardly any other timber would endure. Taking all its good qualities into consideration, Trincomallee wood seems likely to prove a good rod-making material, and it could be got without difficulty from either Ceylon or Madras.

Parrotia Jacquemontiana is widely distributed, at considerable elevations, on the slopes of the North-West Himalayas. It is of small size, and for toughness and elasticity its wood surpasses that of almost any other tree with which we are at present acquainted. Its twigs are employed in making the thick ropes used in the construction of the suspension bridges, by which streams and ravines on the hills of Northern India are crossed.

Other Indian timbers, which would undoubtedly prove excellent material for rod-making are:—*Grewia oppositifolia*, found in the North-West Himalayas. *Grewia tiliifolia*, widely distributed over Northern and Southern India, and used for carriage shafts, oars, masts, &c. *Grewia vestita*, found in Northern and Central India, and in Burma (a strong and supple wood, clean and straight in the grain): and *Heritiera littoralis*, widely distributed along the

* Or Burma.—*Hon. Ed.*

coasts of Northern India, and on the shore of Burma, and the Andaman Islands. The latter is largely used in Calcutta, and is altogether a promising wood for it could be easily obtained from Calcutta, where it is sold under the name of Sundri.

Ougeinia dalbergioides, *Dalbergia sissoo*, *Artocapus fraxinifolius*, *Hardwickia binata*, *Acacia catechu*, *Lagerstrœmia tomentosa*, *Gmelina arborea*, *Areca catechu*, *Caryota urens*, the cocoanut palm (*Cocos nucifera*), and the Palmyra palm (*Borassus flabelliformis*), all widely distributed throughout India, and yielding valuable timbers are also mentioned, as well deserving of trial by rod makers.—*Timber Trades Journal.*

Indian Woods for Matches.

The Conservator of Forests, Bengal, lately brought to notice that he had been in correspondence with the Bengal Safety Match Manufacturing Company regarding the most suitable kinds of wood for match-making. After extended experiments the following kinds of wood are considered by the Company to be suitable for match-making—

Elæocarpus robustus
Evodia fraxinifolia
Abies Webbiana
Juniperus recurva
Alnus Nepalensis
Magnolia Campbellii
Heptapleurum elatum
Sambucus javanica
Symplocos lucida
Do. ramosissima
Gmelina arborea
Excœcaria Agallocha

At present the Company is using *Excœcaria Agallocha* exclusively, and they are able to obtain this wood delivered in Calcutta from the Sunderbans Forests at 3 annas a maund, and they use some 3000 maunds of it a month. The wood of *Excœcaria Agallocha* is fairly well suited for the purpose and the matches made from it, selling in Calcutta at a wholesale price of 11 ans. per gross, are at least as good as the Japanese matches which at present flood the Calcutta market. They ignite easily and are not much affected by damp, but they have the serious defect of glowing for some time after they have been extinguished.

It has been ascertained from Conservators in the various Provinces, that of the other woods mentioned above the following only are available in any quantity, and in such localities as to

permit their being delivered at a Railway station at reasonable prices :—

Kind of timber.	Price.	Circle.	Place where the timber could be delivered.	Price
				Rs. As. P.
Abies Webbiana	N. W. P.	School	Jagadri, N.W.R.	0 5 0 per c. ft.
Do. do. Also Abies Sunthiana	Panjab.	Panjab	Jhelum, Wazirabad, Lahore, Beas, Daroba	0 3 0 to 0 5 0
Gmelina arborea	U. Burma	Western	Rangoon	15 0 0 a ton
Do. do.	L. Burma	Pegu	Rangoon	6 0 0 to 12 0 0 a ton

Limited quantities of Gmelina arborea might also be delivered at Mandalay at Rs. 3-2 a ton exclusive of royalty.

Other woods which have been suggested as suitable for the manufacture of matches are—

Aerocarpus fraxinifolius, Artocarpus integrifolia, Bignonia indica, Grewia hirsuta, Bombax Malabaricum, Nauclia cordifolia, Tetrameles nudiflora, Anogeissus acuminata, Boswellia thurifera, Populus ciliata, and *Pinus Khasiana*, but whether any of these can be successfully used commercially is a question which needs further investigation.

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The Attraction of Bark Beetles to damaged trees.

During his researches regarding the effects of lightning on forest trees, Dr. Robert Hartig made some very interesting discoveries concerning the attacks of Bostrichi and Hylesini on wounded trees. He found on such trees thousands of points where beetles, chiefly the *Bostrichus curvidens*, had bored into the Cambium, and that these bore holes had all more or less healed up; and noticed that many of the old scars on the wood were of some ten years standing. Dr. Hartig thinks that the insects were attracted by the smell of the wounds on the stem, and, believing the tree to be diseased, attacked it, and that finding out their error on boring into the Cambium, and that they had to do with a healthy growing tree, turned back without depositing their eggs. The amount of moisture in the Cambium layer and in the new wood of a growing tree is unsuitable for the beetle and is deadly for its larvæ, which suffocate therein for want of oxygen. It is only in unsound trees, or trees which have ceased to grow on account of suppression, or for other reasons, where but little moisture is present between the wood and the bark and where air is found in addition, that the propagation of Bostrichi and other beetles of the sort can take place. It is not necessary that the whole tree should be unsound to insure the successful propagation of Bostrichi or other insects which breed under the bark or in dead wood, for it has been observed that where a part of a tree has ceased to grow, successful breeding has taken place therein. This fact would seem of special importance with regard to the large number of trees which year by year are seriously damaged by our jungle fires in Burma and elsewhere. It would be interesting to ascertain by research whether it is really the smell of wounds on trees which attracts the insects, or whether they make such unsuccessful attempts to find breeding places on trees indiscriminately and without the presence of any such attraction.

It is not many months since I watched for half an hour a very handsome Sirex making most uncalled for, and unsuccessful attempts to utilize the barrels of a twelve bore rifle, but perhaps *the instinct to place its offspring* in suitable conditions is more highly developed in a Bostrichus.

S. A. C.

The Cultivation and Manufacture of Rhea Fibre.

At a meeting of the Indian section of the Society of Arts on the 25th March last, an interesting paper was read by Mr. Thomas Barraclough on *the cultivation and manufacture* of Rhea Fibre.

Rhea, ramie, or China grass, is prepared from various species of Boehmeria, but the best fibre is obtained from B. tenacissima cultivated in Java, Sumatra, Borneo, Malacca, India, Mexico, and other tropical countries, and B. nivea, commonly cultivated in China. The conditions necessary for the successful cultivation of the plant are described by Mr. Barraclough as follows :—

" Warm moisture is the first requisite to the soil for cultivation, but anything approaching stagnation of water on the land, even for a short period, is the ruin of an estate. Plenty of water always *in the soil and yet ready absorption* of all that falls, are true essentials in ramie land. This implies friability of surface soil to soak in the moisture, and porosity of the subsoil to absorb this excess of water or heavy rains. The land must be sufficiently elevated to run no risk from floods."

" Moisture and warmth in the land depend largely upon moisture and warmth in the atmosphere. Therefore a plentiful rainfall is indispensable, coupled with a high and even temperature. The rainfall must not only be plentiful but it must be well distributed throughout the year. The greatest enemy of ramie after stagnant water is drought. Dry heat burns it up; drought kills it outright. What ramie requires is a naturally rich soil, plenty of rain and no extremes of temperature."

This does not sound very promising for the cultivation of the plant in India, where there are few localities not subject to a more or less prolonged dry season, which must prove a considerable drawback in competing with countries where the rainfall is more equally distributed.

Possibly this accounts also to some extent for the curious fact noted by Sir George Birdwood, that the cultivation of rhea seems to succeed everywhere, whether *in the tropics or the* north temperate zone, except in India, its native habitat, but more probably the principal reason is that in the parts of India best suited for rhea cultivation, labour is almost invariably both scarce and dear. Assam, where the labour

difficulty appears to have been more or less overcome, is we, believe, the only Indian province which exports rhea to Europe. The plant is also grown on a small scale (for export to China) in the Shan hills of Burma, where the conditions of soil and climate seem favourable, but the difficulty of procuring labour and the high rate of wages, are likely to prevent its cultivation on a large scale in that region for some time to come.

Mr. Barraclough controverts the opinion usually obtaining, that the rhea plant is best propagated by cuttings, and advocates raising plants from seed, quoting the experience of Mr. Matthieu of Singapore.

"It is commonly said that an ounce of practice is worth pounds of theory, and it may not be amiss to give here the results of my own experience in ramie propagation by seed. It requires great care, but if the seed be good, the results obtained are an ample reward for the trouble taken. My first attempt ended in failure. One month later I sowed some seed on a bed made of fine sifted earth with a slight admixture of well rotted cowdung; the bed was well sheltered by a lallang roofing, and in fine, every precaution was taken to ensure success. The result was far from satisfactory ; little patches of green here and there showed that germination had partially taken place, but the sowing was practically a failure. I then referred to the precepts given by "The Imperial Treatise of Chinese agriculture" on the subject of the rearing of the plant. This works says:—" For the purpose of sowing, a light sandy soil is preferred. The seeds are sown in a garden near a river or well. The ground is dug once or twice, then beds are made and after that the earth is again dug. The ground is then pressed down with the back of a spade. When it is a little firm it is slightly raked, the beds are watered, and again loosened with a fine rake and finally levelled. After that a ching (a measure) of moist earth ; and a ho (a measure) of seeds are taken and well mixed together. After having sown *the seed it should not be covered with earth, indeed earth on* the top prevents germination. Cover with a slanting roof of matting. Before the seed begins to germinate or when the young leaves first appear, the beds must not be watered. By means of a broom dipped in water, the roof of matting is wetted so as to keep the ground underneath moist. When the plants are about two inches high the roof may be laid aside. If the earth is dry it must be slightly moistened to a depth of about three inches. A stiffer soil is now chosen and formed into beds to which the young plants are to be transferred !"

"I followed the Chinese method in all its minuteness, with the most gratifying results. I have therefore no hesitation in stating that of the three modes of propagation open to the ramie planter, seed, stem, or root cuttings, the first appears to me to be the most practical, the cheapest, and probably the quickest in the case of a large estate."

Mr. Barraclough would substitute for the above the following concise directions :—

"Germinate the ramie seed in open boxes in a roofed house. Fill the boxes with earth ; for top soil take a light loam, pulverise it thoroughly by passing it through a ¼-inch sieve : a slight admixture of burnt earth or dung will keep it moist without it being necessary to water it for some days. Mix a small quantity of seed with one basketful of the prepared soil. Sprinkle this soil over the earth in the boxes. Do not water until after five or six days (sometimes ten days) when the seminal leaves begin to appear. When watering, use a very fine rose. When the young seedlings are two inches to two and a half inches high, transfer them to the nursery in specially—prepared beds, planting them 3 inches apart. If taken out with a ball of earth round their roots they bear transplanting well, and from that time need only the usual amount of attention and care which all young plants require—shading, watering, and weeding."

It is said that propagation by cuttings is apt to cause degradation of the plants, and that it is necessary from time to time to revert to seed to obtain a healthy stock. Close planting is recommended by Mr. Barraclough in order to prevent the formation of branches, as each branch breaks the continuity of the fibres and causes a larger proportion of short fibres.

Mr. Barraclough is strongly in favour of the manufacture of prepared rhea fibre at the plantation instead of exporting the raw material in the usual form of ribbons, and recommends for this purpose a machine recently invented by M. Faure. The discussion which followed the reading of the paper was devoted mainly to the respective merits of this and other processes, but as pointed out by Sir George Birdwood, in a letter subsequently written, the great problem of the movement is not to produce a perfected machine or process for the manufacture of the fibre, but to find a constant and cheap supply of rhea for keeping the machine, or process, in profitable operation. Including China Grass, the amount of raw rhea at present annually consumed in Europe is estimated at 2,200 tons; for which prices are paid varying from £8 per ton for the lowest grade of ribbons, to £35 per ton for hand prepared China Grass, and the consumption would doubtless increase enormously if supplies were made available.

III.-OFFICIAL PAPERS.

A New Method of Tree Planting.

The following article from the "Meldura Cultivator" regarding a new system of tree planting initiated by Mr. H. M. Stringfellow, of the United States Department, of Agriculture, is published as a Departmental Bulletin for the information of fruit growers in these provinces.

The writer strongly urges that when 1 to 2-year old trees are planted, the roots be cut back to stubs about an inch long and the trunk pruned to a branchless whip from 1 to 3 feet high. It is maintained that by this means new roots grow strong and deep, almost directly downward, thus avoiding the drought that often affects the surface roots of young trees planted in the ordinary method. Successful experiments are cited in support of this method, and especially a peach orchard of 100,000 trees planted in Georgia in this way.

It is directed that the roots be cut cleanly in a horizontal plane, a hole 2 inches in diameter dibbled in well-worked soil, the tree inserted, and the earth tramped close around it. The system has been proved by Mr. W. Gollan, Superintendent, Botanical Gardens, Saharanpur, to answer admirably in India in the case of apples, pears, vines, peaches and plums, provided *that they are operated on when dormant, or in these provinces* from the 20th December to 20th January. It is not advocated for mangoes, leechies, oranges, loquats or other evergreen fruit trees, and can only be successfully followed between the dates named.

D. C. BAILLIE,

Director, Land Records and Agriculture,

N.-W. Provinces and Oudh.

The Revolution in Tree Planting.

About eight years ago it was announced by Mr. H. M. Stringfellow, a Texas orchardist of large experience, that the theory and practice of tree planting, as handed down from time immemorial, were wrong, and that instead of a tree being the better for having numerous roots when reset, the very opposite was true. Mr. Stringfellow then gave a full history of how he happened to hit upon this truth as well as a detailed account of various experiments upon a great many kinds of fruit and shade trees that seemed to demonstrate the truth of his statement.

The statement did not at that time meet with much support, so absurd did the idea of cutting off all the roots of a tree seem to even the most prominent horticulturists. Mr. Stringfellow,

however, "stuck to his guns," and in a recent issue of the Texas *Farm and Ranch* he again dealt with the subject, and at the same time he gave the experience of other horticulturists in support of his contention. The article is reproduced below for the consideration of our readers:—

"*Though I have written to quite a number all over the* country, the invariable answer has been, 'While such treatment may succeed with you, it would be out of the question here.' The fact is we inherit our opinions and ideas, just as well as the peculiarities of our bodies, and so true is this that the contrary of their beliefs is positively unthinkable to many men. An instance of this came to me in a letter from one of our most progressive nurserymen. He writes: 'I have been practising close root-pruning with perfect success for some years, and yet my father, who is seventy years old, and sees the good results every year, won't admit them, but *persists in saying that "if the roots were not necessary* they wouldn't be put there." So firmly indeed has this long root fallacy become embedded in the human mind by ages of practice, that even a man of Charles Downing's eminence in horticulture declares in his great work that the 'ideal transplating' would be to take up a tree with its roots entire.

"That this would be absolutely the very worst form, anyone can easily demonstrate for himself. Let him take, for instance, two peach or other tree seeds, and plant a few inches apart in, say, a ten inch pot of good rich soil. At the end of next year let him take them out and carefully shake off all the soil from their roots and plant side by side in the open ground. Let him spread out in a large hole all the roots of one tree according to the inherited regulation method, and cut back all roots on the other to about one inch, and the top to one foot—just enough to allow of it, being stuck down about six inches, like a cutting. Treat alike and in two years the root-pruned tree will be many times larger than the other.

"And here I wish to say, very particularly, that the great superiority of close root pruning is not always so apparent the first year, the tree giving more attention to striking deep roots than to making top. Even for several years, we all know, trees as ordinarily set do well, but this is due to the fact that a large amount of root is removed even then.

"But a comparison with these will prove that when the strain of fruit bearing comes, the close pruned tree—with its roots deep and strong, out of reach of the plough, winter's cold and summer's heat and drought—will *stand up for many years, giving good* crops long after the other, with its lateral and surface system, has broken down and died.

"How else are we to account for the early decadence of our latter day orchards? The planter in his haste for fruit demands big trees with plenty of roots and top, to support which, and to make them live, the nurserymen often transplant several times.

This gives a mass of fibrous roots, which will undoubtedly—if the season is good—make the trees live, but practically dwarfs them and destroys their future usefulness. While Samson lost his strength through having his hair cut off, a tree is for ever weakened by leaving its 'hair' roots on when set, for it seems then compelled to re-establish itself by emitting new fibrous roots entirely from these. This results is a permanent lateral and surface system. Sink a spade round such a tree a year—or even two—*after planting, and a slight pull will lift it from the ground*, a short root-pruned tree will resist any effort.

"The whole theory of the latter method is simply copying Nature. She starts her tree from seed, with neither tops nor roots and universal experience has shown that these and trees grown from cuttings (which are practically seed) if never moved, are the strongest, healthiest, longest-lived and most productive.

"The advantages I claim for this method—over the all-important one of giving better trees—are ; First,

"AN ENORMOUS SAVING

to the nurseryman in digging his stock, which now must be taken up with roots a foot or more long. Second, an equally great saving in packing. Instead of great bales of tops, roots, moss, bagging and rope, and labour of putting up the same, or large boxes containing thousands of pounds of the same useless dead weight, a thousand root and top pruned trees could be packed in a medium size, tight box, with a layer of wet moss in the bottom to maintain a moist atmosphere, and shipped with perfect safety around the world.

"THE SAVING TO THE BUYER

will be even greater. As an instance, several years ago I ordered 5,000 grape vines from California, and wrote specific directions for root and top pruning as well as packing, and offered to pay for the extra pruning, the box to be sent by express. The nurseryman setting me down for a crank or fool, packed the vines—top, roots and all—*in three immense bales weighing 1,300lbs, for which he* got a special rate, and yet they cost me £14 charges. I pruned and packed them in a single bale weighing 127lbs., and shipped them 250 miles, after which they were set by being simply stuck down into well pulverised ground and tramped, the whole operation taking but two days. Every vine grew, and next summer—the *third year*—I expect to ship grapes by the car load. It would be hard to estimate how many thousands of pounds are annually paid by planters to railroad companies in charges on worse than useless tops, roots and packing.

"HUNDREDS OF POUNDS WILL BE SAVED IN THE PLANTING.

Instead of large holes and spreading out of roots, and working in the soil by hand, as now practised, the planter will prepare his

ground, stretch a strong line with tags tied at the right intervals, make a small hole with a dibble a couple of inches in diameter, stick the trees down the proper distance and when the row is done, turn back and tramp thoroughly. The tramping is very important. I will now repeat

"DIRECTIONS FOR ROOT PRUNING.

Hold the tree top down, and cut all roots back to about an inch, more or less, sloping the cuts so that when the tree is set the cut surface is downwards. Experience has shown that these roots are generally emitted perpendicularly to the plane or surface of the cut. This final pruning should be done shortly before planting, so as to prevent a fresh surface for the callous to form. If trees are to be kept some time, or shipped by a nurseryman, about two inches of root should be left, the planter to cut back as directed when the tree is set. About a foot of top should be left. More or less makes no difference. If the tree is well staked, three feet may be left without diminishing the growth much. I have had six foot trees, well staked, grow finely, but to avoid staking and to secure a new straight body it is best to cut back short.

"Let all shoots grow until a foot or so long, when the straightest and best should be left and all others rubbed off.

"I could give the experience and endorsement of quite a number of orchardists who have practised this method with uniform success, but space will not allow me to mention but one. He stands on the topmost round of the horticultural ladder, and as far as I know is the only man whose mind is so unbiassed by the prejudice of preconceived opinions, and his perceptions so intuitively correct, that as soon as the method and reasons for it were presented, he saw its truth. Without waiting for the slow demonstration of experience, he at once put it in practice on his great 900 acre peach orchard of 100,000 trees, which he was about to plant in Georgia. I wrote him recently as to how it turned out. Here is the reply :—'*Dear Sir, I am glad to state that the close root pruning* which was practised when planting our entire orchard of one hundred thousand trees at Fort Valley, Georgia, proved to be the most successful operation we ever practised, less than one-half of one per cent of the trees failing to grow and all making the most vigorous and even growth, I have ever seen in any orchard in America. The orchard is now three years old, and gave us an enormous crop of fruit this past season. I am thoroughly in favour of this system of root pruning.

Your very truly, J. H. HALE,

"And now in conclusion, in view of the fact that my individual effort of eight years have amounted to practically nothing, the question is how to bring about in the general handling of trees this radical but needed reform. I see but two ways. The first through

the medium of the nurseryman and his catalogue, and the second through the bulletins of the experimental stations.

"Quite a number of nurserymen are now practising my method exclusively, and with perfect success, in all their nursery transplanting operations, but they dare not advise the people to adopt it for fear of being accused of trying to induce them to kill their trees, so as to sell them more next season. Mr. Hale is the only exception I know in the whole country who comes out boldy for close root pruning. Now let all the rest make mention of the subject in their future catalogues; next let the State experimental stations make exhaustive experiments on all kinds of trees, vines and small fruits, planting some with mere stubs of roots—a half-inch—and others with five, ten, fifteen and twenty inch lengths, setting enough of each to allow of taking up some every year to demonstrate at once that beyond a length of two or three inches the quantity and size of the new roots is invariably in an inverse ratio to the amount of old roots left on. The more and longer the *old, the less, more lateral and weaker the new ones.*

"Let them subject trees of different ages and length of tops to four or five years of the same treatment, and the result will be the same. The older close root pruned, even with four foot tops will, if staked, quickly re-establish themselves on strong, deep, new roots and make fine trees, while the same age long root ones will become permanently surface rooted and dwarfed for ever. No *amount of fertilising or cultivation will ever make them catch up.*'

THE

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The cultivation of Teak in the Dutch Netherlands.

Abridged translation of an article by R. Seubert in the "Forst- und Jagd-Zeitung."

The Dutch Government possesses in its Java Forests, a most valuable property which for many years past it has been doing its best to improve.

The Forests of Java and Madura, (an island under the administration of Java) are officially divided into two main classes, teak and jungle wood forests. The former are all under regulated management, but of the latter, only those at high elevations, which are important from a climatic point of view, are subject to rules which are not very strictly enforced.

Teak, locally called Djati, is found both in Java and Madura and in a few of the islands further east. In the rest of the Archipelago, especially Sumatra, repeated attempts to acclimatize teak have yielded no satisfactory results, and it may be taken for granted that the failure of the tree in these parts shows that the climate is unsuited to it, and that future attempts to introduce it will be equally unsuccessful. In Java also endeavours have been made to grow teak outside its natural habitat, both towards the west and at higher elevations, but here again it has been found that in the absence of certain necessary conditions of soil and climate it is useless to expect any favourable results.

Although there is is no prospect of teak being extended beyond its natural home, its cultivation within its proper limits is very easy, provided the conditions are favourable, as it grows rapidly and after a short time requires no further attention.

Before going on to describe the present methods of cultivation it is necessary to mention the endeavours which have been made to reproduce the teak tree by natural means. There has been no lack of such attempts and although occasionally good results have been obtained, in most cases they have ended in failure. It is true

that in Java a secondary growth is found wherever the original virgin forest has been removed, but such growth generally consists of coppice shoots, which although they grow luxuriantly, are very liable to become hollow and are consequently unsuited for the production of timber of full size and value.

In many cases, where for instance cultivation is too difficult or where it is profitable to dispose of large quantities of firewood, advantage is taken of the great power of coppicing which teak possesses, and the trees are felled as close to the ground as possible in order to favour the development of stool shoots.

The present method of exploiting the forests is the chief obstacle to their natural regeneration. A block of forest is leased to a contractor and every year a certain area has to be felled, but in order that the timber (a portion of which the State is compelled to buy for its public works) may be brought to market fully seasoned and in the best possible condition, the green trees are killed by girdling about two years in advance of the felling, the girdling being preferably carried out at the commencement of the rainy season (November and December). The girdled trees lose their leaves in a very short time, and owing to the increase of light and the heavy rain coming together, the seed lying on the ground germinates freely, but at the same time undergrowth and weeds of all sorts spring up with the greatest luxuriance, especially the alang alang grass, and a speceis of lantana. The ringed trees also, although they die above the girdle, send out in the course of a few months from below the girdle a mass of large leaved shoots, and in a short time what was fairly clear ground becomes an almost impenetrable jungle, which is fatal to the light-demanding teak seedlings; any attempt to free the latter would be useless on account of the felling which has to be made later. The few seedlings that survive are destroyed during the felling operations and when the area to be planted up is, at the close of the felling year, handed back cleared of all growth, according to contract, the ensuing rains produce nothing but a very sparse crop of seedlings, as during the two previous years no new seed has been produced by the dead stems. So long then as the exploitation is carried out by the above means the natural regeneration of teak is out of the question.

The following is a description of the method of cultivation at present practised.

As the work to be done consists mainly in planting up cleared blocks, there is no choice as to the area to be operated on. Any ground which was once covered with good teak forest possesses the necessary conditions for a new plantation, though, of course, any included patches which were entirely or principally occupied by jungle woods or were blank, require some consideration. Next to the suitability of the soil for cultivation, the most important condition is the degree of moisture contained in it. Planting is useless in places, where the latter exceeds a certain amount, or

in ill drained places where water stagnates, the teak plant requiring good drainage and being very susceptible to excessive moisture. Even when mound planting is resorted to, the young plants, though they make good growth at first, very often eventually succumb or develop into badly shaped trees. This also happens in the case of plantations made on ground with an impermeable subsoil, though the surface soil may be to all appearance good. The presence of more or less pure groups of junglewood in teak forest, as for instance on the banks of rivers or on low lying ground, generally points to excessive humidity and such places should be avoided.

The best teak forest is found on soil derived from the tertiary formation, a belt of which crosses Java in the direction of its greatest length, forming long ranges of very broken hills. Here on the hard clay or marl soil, which often contains a large proportion of lime, and which seems to suit no other kind of tree, the teak is quite at home and grows in forests either quite pure or with a sparse admixture of other species. * The forests are however much cut up by the spread of cultivation and have almost disappeared from the valleys. Teak is also found on volcanic soil at the foot of the hills and on alluvial ground, but in such places it is less abundant and mixed to a greater extent with other trees. The timber grown on such land is also smaller and inferior in quality to that found on tertiary soils and the more fertile volcanic soils favour a rank development of tropical vegetation which gradually drives out the teak tree.

After many years of experimental teak cultivation, more or less successful, but always uncertain, the system now almost exclusively adopted is that of planting or sowing combined with field crops†. In Germany the crops grown under this system usually belong to the owner of the forest, by whom they are raised, but in Java they are the property of the cultivator, who, in addition, is paid for the teak plants at rates which vary according to local circumstances. The customary unit of area in Java is the " bahoe " or " bouw " (pronounced bau) = 7096·5 square metres or about 1·75 acres, and the rate paid varies from f 10 to f 40 per bahoe (about Rs. 8 to Rs. 31 per acre), but the average usually lies between f 20 and f 40 per bahoe, (or Rs. 16 to Rs. 24 per acre).

The profits which accrue to the native cultivator from teak cultivation are by no means small, as he not only gets a much higher return for the two or three crops of miscellaneous produce grown on the rich virgin soil of the plantation than he would from his own exhausted fields, but receives in addition a money payment for the teak plants, besides being let off his land tax.

* The associated trees are generally Lagerstroemia reginæ, Shoutenia ovata, Butea frondosa, and Schleichera trijuga.

† Practically the same as our Burma method of Teak Taungya cultivation.
HON. ED.

But it is nevertheless often extremely difficult to convince the suspicious Javanese cultivator of the reality of these advantages or to persuade him to undertake this form of cultivation, and it is often still more difficult to get him to carry out the conditions agreed on in a loyal manner. The Forest Department cannot use force as the contract is an optional one, and under the local laws breach of contract is only punishable when fraudulent intention can be proved. Practical considerations prevent recourse to a Civil Court, especially when the defendant is a pauper.

Consequently the negotiation and carrying out of a planting contract is a very difficult business, requiring a great deal of patience and tact on the part of the European Forest Officer; good subordinates are a great help, but they are often wanting. In some districts, for instance, Tegal and Pokolongan, in which the Taungya plantation system was introduced by the present Inspector of Forests over 20 years ago, the people have learnt to fully appreciate the advantages of the system and undertake the work willingly, but in other parts of the island it is only with the greatest difficulty that they can be induced to carry out the work, and often refuse altogether to have anything to do with it. In such cases, cultivation has either to be abandoned or carried out departmentally, which costs a great deal more than contract work and is seldom as successful, owing to want of supervision, the forest charges being very large and the subordinate staff weak and often very badly paid. The cost of departmental cultivation amounts to f 40 to f 60 per bahoe (Rs. 24 to Rs. 48 per acre) and under unfavourable circumstances, often to a good deal more.

A few months before the rains, which begin in November, the Forest Officer in the presence of the local Javanese headman makes an agreement with the villagers for the new cultivation, the conditions being clearly laid down and the name of each cultivator and the land he is to plant entered in a list; a part payment is generally made in advance at the same time. The negotiations do not always proceed smoothly and many meetings are often necessary before the matter can be arranged to the satisfaction of both parties. It should here be noted that the agreement holds good until the young plants are able to take care of themselves, (under ordinary circumstances a period of from 15 to 18 months) and that payment is made in instalments. The presence of the forest officer is necessary at each payment in order to prevent disputes and the pay sheets are also signed by the local native official.

The following are the conditions of contract in the district managed by the writer.

The contractor binds himself to commence preliminary work as soon as the cleared area is made over to him, towards the close of the dry season, so that the sowing can take place at the commencement of the rains.

The preliminary work comprises the more complete cleaning of the ground, pegging out the sites for the plants (the usual planting

distance is 3 ft. × 10 ft.) and finally the breaking up of the ground in patches of a foot square at each peg, and as deep as the hardness of the soil will allow.

When this is done the cultivator has to sow the seed, which is provided for him by government, putting in 4 or 5 seeds at each peg.

After that he has to sow his field crops between the rows, and in carrying out the cultivation necessary for the latter, to take care of the young teak seedlings.

He must raise two field crops during the first agricultural year (1st July to 30th June) and if necessary a third crop in the following year.

In any case, he must keep the ground weeded during the second rains in order that the plantation may be handed over clear of any growth that would be likely to suppress the young trees.

The cultivator is responsible for filling up any blanks that may occur.

In return for the above work the cultivator has the right to the full use of his crop without paying the customary land tax. Any wood left on the ground becomes his property and he is paid at the rate of f 30 per bahoe (Rs. 24 an acre). The payments are made in 5 or 6 instalments, the first as an advance, at the time the contract is made, and the last when the plantation is handed over at the end of the second rains.

The agreement is a verbal one and is made in the presence of the headman of the district, the fact of taking the advance being considered as proof of acceptance of the conditions.

The forest officer would then have no further trouble with his plantations, if only the good Javanese cultivator would adhere strictly to the terms of the contract, but as a matter of fact the plantations are generally a constant source of anxiety to the forester, the cultivator being apt either to let the time for sowing slip by or else to allow the young plants to be choked by weeds, in which case there is nothing left but to complete the plantation departmentally as far as practicable.

There are districts where owing to a wholesome competition for the contracts the people take pains to carry out the conditions of the contract and bring the plantations to a great degree of perfection, but on the other hand there are tracts where nothing will induce the people to take to the work, and where it has then to be done on daily labour, which notwithstanding the low rate of wage, 25 cents (5d.) is always much dearer than the other method.

Next to an excess of moisture in the soil, weeds are the principal enemy of the teak plant and among these the alang alang grass (*Imperata arundinacea*) is the worst. No one unacquainted with the tropics can form any idea of the dense rank growth of this grass.

In teak plantations, all that is necessary is to keep the ground clear and the soil loose during the first two years or at any rate to keep down the growth of alang alang grass. As soon as the young teak trees attain a height of from 12 to 15 feet, which is usually during the second rains, they are practically out of danger and still more so in the 3rd year when they begin to close up. They are then able to withstand the numerous fires which occur during the dry season.

As the canopy becomes more complete the alang alang disappears, at least that portion of it that is above ground, and gives place to a harmless undergrowth.

The teak seed ripens during the dry season (July or August) when it is shed in abundance, and is collected from the best grown trees. Before sowing, the teak seed is sometimes roasted, by covering it up with straw and setting the latter alight. This procedure is not necessary but is often recommended and is an old standing custom.

The seed is sown in the beginning of the rains, not earlier than October and not later than December. Three to five seeds are put down at each peg and covered lightly with earth. At the same time, what remains over of the seed is spread out in beds here and there between the rows, or merely scattered on the ground in order to have a reserve of planting material. Owing to the protective covering of the teak seed, a little dry weather does no harm and it is a disputed point whether it is better to sow just before the rains or to wait until they have fairly set in. The Javanese cultivator prefers the latter, and there is often much trouble in getting him to sow early enough in the season.

When the seed has been sown and the rains have fairly set in the cultivation of field crops should be started as soon as possible. Maize is one of the most suitable crops for both interests, though in many places people prefer planting a species of hill paddy, but where this plant is cultivated the soil is not so well tilled and the young teak plants are liable to suppression as the paddy ripens.

If the rains are favourable, the seed germinates in about 8 days, or at most a fortnight or 3 weeks after sowing. In good years there is usually a superabundance of plants, as most of the seed germinates. For transplating, quite young seedlings with from 2 to 4 leaves and unlignified stems are the best, seedlings that have come up in the previous rains should be absolutely rejected.

The second crop is sown in March or April, either maize a second time, or else some such crop as cotton, castor oil, chillies, beans, tobacco, &c. The forester prefers the latter, as it does not suppress the teak plants and entails constant attention to the soil.

At the time of the second harvest (June or July) the weather is very dry and a thorough cleaning of the ground is necessary, as a precaution against fire. The teak plants are by this time about

5 feet high. Except in exceptionally dry years or on dry exposures, the young plants retain their uppermost leaves throughout the dry season, although older trees are leafless at this time of year.

A further tilling of the ground is desirable in the 2nd year and is indispensable where the alang alang makes its appearance or where the ground gets covered with short thick growth of grass. Dry rice cultivation is at this time very appropriate. At the end of the second year the teak plant has attained a height of 19 to 20 feet but is still unbranched.

The plantations are taken over at the end of the second rains after undergoing a final weeding. Weeding in the 3rd year is only necessary in backward areas; anything that requires weeding after this is not worth the labour entailed.

The branches begin to develop in the 3rd year and the canopy gradually closes so that the weeds become fewer. If the trees are planted 3 feet by 10 feet and the growth is normal, thinning becomes advisable about the 3rd year, but for want of the necessary establishment, this measure cannot usually be carried out. Later on the people of the surrounding villages undertake this work without authorization and are careful to remove the best trees.

Indian Timbers for Fishing Rods.

With reference to Surgeon-General Bidie's paper on the above subject in the Fishing Gazette, I may perhaps be allowed a few remarks, as I have for some years been experimenting in this direction. Why Surgeon-General Bidie calls Thespesia populnea the Indian Seaside Mahoe, perhaps goodness only may know, at any rate I never heard it called by that name before. The wood, however, not the name, is the important thing. It is an excellent tough and elastic timber. most of the Bombay carriage wheel spokes and ekkas are made of it. I made golf sticks of it, and found it at least as good as the imported ones. It would certainly do for fishing rods, bar the top-joints.

Parrotia Jacquemontiana I looked at pretty frequently, but came to the conclusion that it was not even worth trying. The wood is no doubt extremely flexible and fairly tough, but is deficient in strength and elasticity, and does not grow in a form at all suitable for rod-making. I searched for many days without finding any trees that I thought worth cutting a rod out of, and Parrotia was common enough in those forests. The Grewias I have cut into rod lengths and seasoned, and think they ought to come to the front. Those I tried were extremely tough and stiff, and elastic, but they had the defect of developing minute cracks in drying, throughout the thickness of the log, a defect that would probably be fatal for trade purposes, unless it can be overcome. The same may be said of another splendid timber, Anogeissus latifolia. Both these trees I have split up into matchwood trying to find a length free from minute cracks. Probably the seasoning could be carried out better than this Ougeinia dalbergioides I have cut up a lot of, having had a great admiration for its strength, toughness and elasticity. It is excellent for shafts and such like large work, but disappointing for fishing rods. However straight the tree, the grain will be found generally very cross and twisted, full of knots and flaws. A rod made of it would be pretty sure to warp in six months. Dalbergia Sissoo I do not think much of, Dalbergia latifolia is better and might do for top-joints. Acacia Catechu is an excellent timber. but I never thought of trying it for rods, if not too brittle, it might do. Heritiera and Hardwickia should make good top-joints, though I never had the opportunity of trying them.

Lagerstroemia tomentosa I do not know, but hear that it is quite useless, Lagerstroemia parviflora and microcarpa I have tried, and found them nice, light, straight-grained, elastic, timbers, but without much strength. Gmelina arborea I never thought worth trying, and do not now, as it is a softish wood of no particular character.

The palms would be excellent, I have had real hard service out of them, they are hard, stiff, tough, elastic as need be desired,

but they have the evil habit of throwing out splinters. Cut and polish with the utmost care, you have only to bend it well a few times, run your hand up it, and pick out the splinters at leisure. The wood tissue is too uneven, very hard fibres embedded in a more or less soft cellular matrix. The outside of the palm alone is good, the interior being principally pith.

F. G.

III.—OFFICIAL PAPERS & INTELLIGENCE.

Agricultural Department, Assam. Bulletin No. 3.

NOTE ON THE CULTIVATION OF RHEA IN ASSAM.

Rhea is cultivated by the *raiyats*, chiefly in small patches near their homesteads, in all the districts of the Assam Valley, except Goalpara. The cultivated rhea known in Assam at the present day, is *Boehmeria nivea*. In the article on Rhea and China grass in the Dictionary of the Economic Products of India, certain evidence is referred to as tending to show that the rhea originally cultivated in Northern Bengal and Assam was a different variety, *Boehmeria tenacissima*, and the suggestion is made that the latter kind may be found more suitable for cultivation in India than *Boehmeria nivea*, as being better adapted to a hot and moist climate. However this may be, the only plant now known and cultivated as rhea in Assam is *Boehmeria nivea*, and though a search has recently been made for *Boehmeria tenacissima* throughout the Assam Valley, not a single specimen of it has been found. So far, also, as the writer has been able to ascertain, there is no tradition among the *raiyats* that any other variety of rhea than *Boehmeria nivea* was ever cultivated in the valley.

Rhea (*Riha*) is the vernacular name by which *Boehmeria nivea* is known in the four upper districts of the valley,—Lakhimpur, Sibsagar, Darrang, and Nowgong. In some parts of the Kamrup district it is known as rhea, and, in others, by the Bengali name, *Kankhura*. The wild rhea (Ban rhea), which is found in the jungle throughout the Assam Valley, is also a variety of *Boehmeria*, but no fibre is ever obtained from it by the Assamese, and it does not appear probable that it could ever be of any commercial value. In the Surma Valley (Sylhet and Cachar districts), no form of rhea is known to the native cultivators, but, on a few tea estates, *Boehmeria nivea* has been raised experimentally on a small scale. On the occasion of a recent visit to the Jaboka Naga tribe, inhabiting a tract of the hills to the south-east of the Sibsagar district, the Reportor on Economic Products to the Government of India ascertained that *Boehmeria nivea* is

cultivated by the tribe, and that they also spin and manufacture into a coarse cloth, the fibre of a jungle plant called by them Ban rhea, which has has been identified by the Reporter as *Villebrunea appendiculata*.

The soil on which rhea (*Boehmeria nivea*) is cultivated should be be light and free, not stiff, and either naturally rich, or well manured. It must also be above the reach of inundation, and well drained, as the plant is at once killed by water lodging at its roots. Subject to these conditions, it would appear that rhea can be grown in Assam on a variety of different soils. In the Assam Valley, the rich loam which composes good tea land has been found suitable for it, and in Sylhet it is reported to be grown most successfully on well-drained *bhil* land. By the Assamese, however, it is most usually raised on sandy loam, which has been artificially fertilised, chiefly with cowdung manure. The crop is generally grown from root cuttings, though in some places stem cuttings are occasionally used, and, according to the statements of native cultivators, can be planted at any time during the rainy season (April to October); but the months usually selected for planting are *Baisakh* (15th April to 15th May) and *Kartik* (15th October to 15th November). The more careful cultivators, if the ground is not already well-drained, and quite secure from inundation, commence operations by digging a trench about two feet deep round the patch selected. The ground must be well hoed. Mr. J. Buckingham, C. I. E., of the Amguri tea state, Sibsagar, who has cultivated rhea experimentally, considers that hoeing to a depth of at least 18 inches is necessary—and manure is applied both before and after planting. The only manure systematically used by the Assamese, and considered by them indispensable for rhea, is cowdung; Mr. Buckingham, however, thinks that decomposed vegetable matter is the best manure. As rhea is grown by the native cultivators close to their houses and cattle sheds, an abundant supply of cowdung manure is usually available for the crop; wood ashes from the cooking hearth are sometimes thrown on the ground, where rhea is grown, but they are not regularly used as manure. Some cultivators mention the use of rice husks as manure for rhea, while others state that the husks are spread on the ground for the purpose of attracting field mice, which render assistance by nibbling, and so reducing the size of the rhea roots, when the excessive growth of the latter results in overcrowding and the consequent deterioration of the stems. This statement the writer has not had an opportunity of verifying. The root cuttings are planted in rows from two to three feet apart, with about the same distance between the rows, and about six inches deep. Mr. Buckingham recommends planting in trenches about three inches deep, and earthing up the shoots as they appear above ground. In applying manure after planting, it is important to avoid choking the shoots by its excessive use. Where the crop is

grown near a village, it must be protected by a strong bamboo fence, as cattle and goats are very fond of the leaves and tops of rhea.

In the experiments made in rhea cultivation at Saharunpur, it has been found that the stems produced are usually unfit for conversion into fibre, owing to the irregularity of their growth, caused by alternations of dry and wet heat, the result of which is that the fibre which they contain is not of uniform quality throughout and that the difficulty of extracting it is enhanced. In the Assam Valley the cultivation of rhea does not appear to be attended with this difficulty. At Saharunpur and in all other parts of Northern India, except Assam, little rain occurs during the months of the cold weather (November to March), and the early part of the hot season, comprised in the months of April and May, and the first half of June, is characterised by intense, dry heat. In Assam there are no dry, hot months, the rains setting in regularly by the middle of April, and even during the cold weather, humidity is greater than in other parts of Northern India. Accordingly, in Assam, rhea continues growing throughout the year, though at a somewhat slower rate in the cold weather than in the rains; and whereas, at Saharunpur, the crop is cut only twice a year, once in June, and once in October or November, in Assam cuttings are obtained at much more frequent intervals, as will be shown further on. According to the statements of numerous cultivators who have been examined, there is no difference, as regards the quality of their fibre, or the difficulty of separating it, between rhea stems cut in the cold weather and those obtained in the rains. The writer has seen, in March, at the end of an unusually dry cold weather, in Lower Assam, stems over six feet high, and apparently uniform, of rhea plants which he was assured, had been cut only two months before. The rapidity of growth, however, especially during the cold weather, depends much on the amount of manure applied and the general care taken in the cultivation. The stems just referred to were grown on carefully tended land, while, at the same time and on land of probably the same natural fertility, the rhea crop observed was withered and stunted, and not likely to yield any fibre till the beginning of the rains.

Proverbially careless and unthrifty, the Assamese *raiyat* is little disposed to take trouble with a crop like rhea, the produce of which is required by him only in small quantites for domestic consumption. It is hence, somewhat difficult to estimate from Assam experience what the crop is capable of under careful cultivation. In the majority of instances, except a little weeding during the first few months of growth, nothing is done for the rhea patch after planting, and its owner looks only to cutting the stems as often as they become fit for use. Under this treatment, after two years, the soil becomes exhausted, and the rhea stems grow weak and thin; the roots are then taken up, divided, and replanted elsewhere. The more intelligent *raiyats*, however,

admit that, with frequent manuring, rhea can be continuously grown on the same land for many years; indeed they place no limit on the length of time for which the crop can be cultivated on the same land if only manure enough be applied. There is room for doubt as to what the maximum period is. In reports from China and America, very long periods, varying from 30 to 100 years, have been mentioned; but it seems probable that unless some process of thinning were resorted to, transplanting at comparatively short intervals would be necessitated by the overcrowding of the roots. In paragraph 8 of Mr. Montgomery's report on the experimental cultivation of rhea in Kangra (Dictionary of Economic Products, Volume VI, Part I, page 472) the removal of the roots every four years is recommended, in order to avoid overcrowding. On the other hand, in the report of the Superintendent of the Botanical Gardens, Saharanpur, quoted at pages 476-481 of the same volume, close planting is advocated, with a view to preventing the growth of weeds and improving the quality of the fibre. By the Assamese the crowding of the roots, as well as the impoverishment of the soil, is sometimes alleged as a reason for re-planting the crop on fresh land, but the writer has seen rhea flourishing on land where it is said to have been grown continuously for eight years without thinning.

In different published descriptions of rhea cultivation, in which the number of cuttings that can be obtained in a year is referred to, it appears to be implied that, at certain intervals, the whole of the stems from roots planted at the same time in a field can be cut simultaneously This, however, is not the usual practice in Assam, where the received opinion is that, in order to obtain the greatest outturn and best quality of fibre, each stem must be cut at a certain stage of its growth, namely, when the lower portion of the stem turns brown, and before the plant has flowered. As all the stems from roots planted together do not reach this stage simultaneously, the custom is to cut selected stems from time to time as they become fit for use. In this way selected stems are cut at intervals of from one to two months in the rainy season, and from two to three months in the cold weather. Rhea planted at the end of the rainy season (October to November) will yield the first cutting about the end of March or beginning of April; if planting be carried out at the beginning of April, the first cutting may be obtained about the middle of May. When the crop has fairly established itself, cuttings may be taken regularly at the intervals mentioned above.

No irrigation is required for rhea in Assam. Between the time of planting and the first cutting, constant and careful weeding is necessary, but, after that, light hoeing between the rows after each cutting, and manuring once a year, if the soil be poor, seems to be all the cultivation that the crop requires.

The method of preparing the fibre in Assam has been described in reports previously published, and may be briefly recapitulated here. After the stems have been cut, the leaves are stripped off, and the green outer cuticle removed by scraping with a knife. The stems are then dried in the sun for from four to six days, after which the bark is peeled off, and left to steep for two or three hours in cold water, in which pieces of some acid fruit are sometimes placed along with it. The acid appears to have the effect of dissolving the gum contained in the bark, and facilitating its removal. After this steeping, the fibre is separated by washing the bark in clean water and rubbing it between the hands.

It is necessarily very difficult to estimate, from the statements of native cultivators, the average outturn of cleaned fibre which may be obtained from a given area of land under rhea which is properly cultivated. As mentioned above, careful cultivation of this crop is the exception, and the *raiyat* who raises it, as a rule, on a diminutive patch not exceeding three or four perches in extent, keeps no strict account of the fibre which it affords, a few handfuls at a time, for domestic uses. The Assamese peasant is, moreover, strongly averse to giving any information about the outturn of his crops, and any statements he makes on the subject are usually under-estimates. Calculations based on such statements, which may be taken for what they are worth, give estimates of outturn for rhea varying from 76 lbs. to 605 lbs. of cleaned fibre per acre. On the other hand, the estimate deduced from an experiment made in the Nowgong district jail in 1885 was 911 lbs. per acre. Mr. Buckingham estimates the outturn under favourable circumstances, at 640 lbs. per acre, and this may probably be taken as a safe estimate for Assam. Mr. Montgomery, after twelve years' experience of rhea cultivation in Kangra, estimated the outturn of cleaned and dried fibre at 972 lbs. per acre, but it seems doubtful whether the fibre produced by him was as thoroughly cleaned as that prepared by the Assamese method.

There are no accurate statistics of the area under rhea in Assam. The crop is found, here and there, throughout the five districts of Kamrup, Nowgong, Darrang, Sibsagar, and Lakhimpur, and is raised by cultivators of all classes ; not by the fishing caste only, as has been stated. In spite of this wide distribution, the total area under rhea is unimportant. In the districts named, its cultivation is confined to a small proportion of the total number of villages, and in any one village, as a rule, not more than half a dozen *raiyats* will be found who cultivate it, while the average area cultivated by each *raiyat* is, as already stated, extremely small.

In the whole of the Assam Valley, the total area under rhea probably does not exceed 2,000 acres. The small extent of rhea cultivation in Assam is easily understood, when the labour involved in preparing the fibre is taken into account, and when it is con-

sidered that the Assamese manufacture from it fishing nets and lines only, and are unacquainted with the higher uses to which it can be put.

Whether rhea can be successfully grown on a commercial scale in Assam, is a question which can only be determined by experiments, such as are more likely to be carried out in a satisfactory manner by private agency, than by a Government department. It is certain that, on this point, no conclusion can be safely drawn from the existing cultivation in the province, which is everywhere of the nature of garden cultivation. The data bearing on this question, which are available, will, however, be of interest to any one proposing to make an experiment with the rhea crop, and it appears desirable that they should be laid before the public. There seems to be no doubt that the climate of the Assam Valley districts is favourable for the cultivation of rhea (*Boehmeria nivea*) throughout the year, while waste land suitable for the crop is available in abundance in those districts. On the other hand, there is no probability that the cultivation of rhea will ever be undertaken on a large scale by the Assamese *raiyat*, owing to the labour involved in the separation of the fibre by hand, and to the fact that any machinery or process by which it could be more easily extracted would be beyond the *raiyat's* means. The present condition of the Assamese peasant is such that he is not compelled to engage in any laborious occupation in order to obtain a subsistence, which is all that he requires, and even the trouble of preparing jute for the market has been sufficient hitherto to deter him from the cultivation of that crop, in spite of the large profits which it would probably yield him. So far as present indications go, it appears that if rhea cultivation is ever to become an important industry in Assam, it must be established there, like the tea industry, by European capital, with the help of imported labour. Before investing capital in this speculation, it would be well if parallel experiments could be made with *Boehmeria nivea* and *Boehmeria tenacissima*, in order to decide which variety thrives best in the Assam climate.

In estimating the cost of rhea cultivation, the frequent manuring which would be necessary, if any but the very richest soil were selected, must be taken into account as an item of expense; but, with regard to this, it may be pointed out that cattle dung has at present no selling value in Assam, not being generally used either for fuel or manure. Immense quantities of this manure at present go to waste annually in Assam; so that its cost would probably be little more than the expense of collecting it and conveying it to the plantation. With reference to the statement of the cost of the experimental cultivation in Kangra, given at page 474, Part I, Volume VI of the Dictionary of the Economic Products of India, it may be observed that rent at Rs. 10. per acre has there been shown as an item of expense; whereas,

in Assam, under the rules for the settlement of waste land for special cultivation, land could be obtained for rhea on thirty years' lease, after certain preliminary expenses, for two years' revenue free, and afterwards at progressive rates rising to Re. 1 per acre, the lease being renewable on its expiration at the ordinary rates of revenue which may be then current in the province. Irrigation, again, which is required for the rhea crop in Kangra, would not be needed in Assam. On the other hand, nothing has been allowed for cost of manure in the statement referred to, and the cost of labour would be considerably greater in Assam than in Kangra.

A question which has to be decided is whether the production on the rhea plantation of cleaned fibre, or of the article now known in commerce as rhea ribbons, that is strips of rhea bark containing the fibres as well as the dried juice or gum, with the outer cuticle adhering, should be aimed at. In the rhea industry, as it at present exists in Assam, dried ribbons are not produced, the outer cuticle being scraped off immediately after the stems are cut; but, in an article which appeared in the issue of *Capital* of the 4th August 1896, it is stated that, in an experiment made *on good soil, the average outturn of dried ribbons obtained*, was 1,600 lbs. per acre. Taking this rate of outturn, it is hardly probable that a plantation could be profitably worked in Assam to produce rhea ribbons, the price of which at Indian ports of export is quoted at only £7 per ton. This low price is due to the fact that the quality of the fibre contained in the ribbons cannot be gauged at the time of purchase. and also to the heavy percentage of waste matter on which freight has to be paid when ribbons are exported. In order to offer satisfactory prospects of profit, it would seem that the cleaned fibre must be produced on the plantation, and it is certain that, in Assam, this could not be done by hand labour, after the native method, except at a prohibitive cost. Some machinery or process seems, therefore, to be required, which shall be simple enough to be put in operation on the plantation itself, and which shall produce, from the fresh cut stems of rhea, cleaned and degummed fibre in the condition in which it is required by the manufacturer in Europe.

F. J. MONAHAN,

Offg Director, Department of Land Records and Agriculture, Assam.

Shillong,
The 12th April 1897.

VI.-EXTRACTS NOTES & QUERIES

The Timber Supply of the British Empire.*

BY PROFESSOR W. SCHLICH, C. I. E., PH. D.

When I, at the invitation of the scientific director of the Imperial Institute, undertook the task of reading a paper on the timber supply of the British Empire, I thought that I had sufficient material for the purpose, but the deeper I went into the subject the more I found that the information which is necessary to deal satisfactorily with the question is very incomplete. There is indeed a vast amount of information available, but it is in many cases given in such general terms that it is not easy to draw correct and reliable conclusions from it. It is, for practical purposes, of very little use to find it stated that a large area of forest is available in a certain country, since that may mean much or very little indeed. In only too many cases the areas include large tracts of country which contain little or no useful timber, while in others the composition of the forests and the proportion in which the valuable timber trees participate in it are not given, and can only be roughly guessed. Under these circumstances I have tried to make the best of the available information, and I trust that the remarks which I am about to address to you may not be found inacceptable. At the same time I hope that I shall have your kind indulgence in case I should have fallen, here and there, into error.

The question of the timber supply of this mighty Empire is of such extent, that it would be impossible to deal with it exhaustively in the course of an hour: hence I shall have to restrict myself to the consideration of a few points which deserve our special attention.

The British Empire is of enormous extent, covering an area of about 9,000,000 square miles, with a population of some 350,000,000 people, leaving out of consideration the lately acquired territories in Africa, about which our information is as yet incomplete. This huge area is scattered over the face of the globe from the North Polar region to the 55° of southern latitude, including all shades of climate from eternal snow and ice to tropical heat, and a rainfall ranging from absolute aridity to more than 500 inches a year.

A further aspect presents itself in the density of population, which differs from the maximum to be found on the earth to the total absence of inhabitants from large areas.

It is obvious that the forestry question of such an Empire cannot be dealt with wholesale, but that it must be studied and

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* Read at the Imperial Institute, 20th March.

answered for each part separately. And yet as regards the timber requirements of the whole a fair idea can be formed, and conclusions arrived at, in how far the available supplies are likely to meet the demand.

This is, therefore, the subject with which I propose to deal to-night, though necessarily only in skeleton form.

The annual statements of the trade of the United Kingdom with foreign countries and British possessions laid before Parliament give the imports and exports of timber into and from the various ports of the Empire, and they thus enable us to estimate the requirements and supplies. I have, therefore, prepared Table I., which shows the mean annual imports and exports for the two periods of 1884 to 1888, and 1890 th 1894.

TABLE I.

Average Annual Net Imports and Exports of Timber into and from the several parts of t e British Em ire, calculated from the Returns for 1884 to 1894.

Country.	Period 1884–1888.		Period 1890–1894.	
	Net Imports	Net Exports.	Net Imports.	Net Exports.
	£	£	£	£
Great Britain and Ireland ...	15,000 000	...	17.595,000	...
Australasia	1,284 000	...	1,233 000	...
Cape of Good Hope ...	72 000	...	160.000	...
Barbadoes	24.000	...	65,000	...
Trinidad	49.000	...	41.000	...
British Guiana	37,000	...	41,000	...
India	...	511.000	...	682.000
Ceylon	...	27 000	...	22,000
Dominion of Canada ...	...	4,025 000	...	3,956 000
Jamaica	...	175,000	...	312,000
British Honduras ...	...	...	...	142.010
Total	16.466.000	4,738,000	19,135,000	5,114,000
Net Imports into the Empire	11,728,000	...	14,021,000	...
Increase of Imports in six years	...	...	2,293 000	...
Mean annual increase ...	...	...	382,167	..

This table is not quite complete, because some of the smaller colonies have been omitted, as well as the newly acquired territories in Africa. In some cases, certain quantities of timber could not be traced, as they had been included under other

headings, as for instance, railway materials. On the other hand, some of the items include logwood, which is used for dyeing purposes, and not as timber. Still, on the whole, the table is very instructive, because it exhibits the following facts :—

1. The net imports of timber into the British Empire amount now to the value of £14,021,000 a year.

2. They have increased in the course of six years by £2,293,000, or at the rate of about £382,000 every year.

I should mention, in addition, that wood pulp amounting in value to $1\frac{1}{3}$ million pounds is now annually imported into Britain which is not taken into account in the above table.

3. The United Kingdom is by far the greatest importing country, the *net* imports amounting to timber valued at £17,600,000. Next comes Australasia with £1,250,000; Cape Colony, £160,000; Barbadoes, £65,000; Trinidad, £41,000; and British Guiana, £41,000. All these colonies export certain quantities of timber, especially hard woods; but they import so much soft wood (pines and firs) that the balance of imports and exports is against them.

Amongst the exporting British possessions, the Dominion of of Canada stands first with £3,956,000; then comes India with *£682,000: Jamaica with £312,000 (which sum includes, however,* much logwood and transhipments from other counties); British Honduras with £142,000; and Ceylon with £22,000.

4. Taking the Colonies and India by themselves, the net exports amount to £3,574,000. Deducting this amount from the imports into the United Kingdom, we arrive at the net imports into the Empire, amounting to nearly £14,021,000.

5. While the annual net exports of the Colonies and India have increased by only about £400,000, the net imports into Britain have increased by nearly £2,600,000.

Here, then, are facts which demand attention, and we may well ask—

1 Whether future supplies are sufficiently assured? and

2. Whether *measures cannot be taken to provide, by degrees,* the necessary timber from sources *within* the Empire, thus preventing this large sum of money going every year to foreign countries?

With a view to answering these questions, we must, in the first place, inquire where the timber comes from and of what description it is. For this purpose we cannot do better than examine the imports into the United Kingdom, since they are much greater than those of the Colonies put together. I have, therefore, compiled Table II., showing the imports into Great Britain and Ireland during the year 1894, this representing about the average of the five years 1890-4.

TABLE II.

TIMBER IMPORTED INTO GREAT BRITAIN AND IRELAND DURING THE YEAR 1894, VALUE IN £ STERLING.

Country whence Imported.	Fir, Hewn and Sawn.	Oak, Hewn and Staves.	Teak.	Mahogany.	Other Furniture Woods.	House Frames.	Miscellaneous.	Total.	
	£	£	£	£	£	£	£	Loads.	Value £
I. BRITISH EMPIRE.									
Canada and Newfoundland ...	3,172,283	147,948	...	.	25,175	19,520	187,551	1,391,199	3 552,477
West Indian Islands, Honduras, Guiana.	...	...	...	116 547	4,971	...	24,756	19,141	146,274
Gold Coast and Niger Protectorate	...	...	...	62,713	4,134	...	...	7,676	66,847
East India and Straits Settlements.	...	...	404,445	...	28,937	3,989	...	43,251	437,371
Australasia	24,557	...	...	...	40,648	566	...	12,222	65,771
Other British Possessions ...	125	50	...	2,418	1,520	1,577	54	988	5,744
II. FOREIGN COUNTRIES.									
Russia	3,721,027	144,411	...	...	20,153	9,473	75,428	1,999,061	3,970,492
Sweden	3 830 458	22,823	...	...	...	89,661	34,665	2,108,226	3,977,607
Norway...	1,369,455	55,332	...	...	...	2,768	8,058	760,471	1,435,613
Germany	548,025	283,161	...	11,423	14,732	115,993	19,445	353,053	992,779
Holland and Belgium ...	...	4 499	...	...	...	139,516	37,263	43,702	181,278
France, Spain, and Italy ...	549,094	3 398	...	...	27,072	69,366	44,243	754 343	693,173
Austria	...	58,827	...	...	...	4,755	...	6,787	63,582
United States of North America,	1,153,663	477,046	...	15,128	365,681	206,922	138,387	668,181	2,356,827
Mexico, Honduras, Columbia, Venezuela, West Indian Islands.	...	...	...	261,308	43,107	...	...	42,477	304,415
Siam	...	...	54,102	...	...	...	...	5,649	54,102
Other Foreign Countries ...	14,620	11,685	7,162	52,322	28,132	4,219	1,047	19,950	119,187
Total British Empire ...	3,196,965	147,998	404,445	181,678	105,385	25,652	212,261	1,474,477	4,274,484
Foreign Countries ...	11,186,342	1,061,182	61,264	340,181	498,877	642,673	358,536	6,761,900	14,149,055
Grand Total, Value ...	14,383,307	1,200,180	465,709	521,859	604,262	668,325	570,897	8,236,377	18,423,539
Number of Loads	7,437,763	242,861	44,333	65 494	87,108	167,081	191,737	8,236,377	...
Mean Value per Load in £ s. d.	£1 18 8	£4 19 7	£10 10 1	£7 19 4	£6 18 9	£4 0 0	£2 19 7	...	£2 4 9

(1) THE first fact which Table II. teaches us is, that of the timber, valued at £18,423,000, only £4,274,000 came from British possessions, while foreign countries sent us £14,149,000, or just about the average annual imports into the Empire.

(2) The second point which deserves our attention is the description of timber imported. Passing over the miscellaneous timber, we come to what is classed as house frames, valued at £668,000. This is worked-up material, coming to a considerable extent from countries which are themselves importing timber; hence it does not represent production, but cheaper labour than we have in this country. The next items are the fancy woods, leaving out mahogany, £604,000. Half of these come from the United States of America, and the other half from a number of other countries. The mahogany, £521,000, comes chiefly from Mexico and British Honduras.

Teak, valued at £465,000, comes chiefly from East India.

The oak, value £1,209,000, comes from the United States, from the countries around the Baltic, Canada, and a few other countries.

The pine and fir timber, value £14,383,000, comes chiefly from the Baltic, Canada, United States and France. This is the most important item on our list, forming 90 per cent. of the total imports.

(3) The third point is the rate at which the timber is laid down at these shores. Table II. shows that teak is valued at about £10 a load, mahogany £8, other fancy woods £7, oak £5, and pine and fir £1 18s 8d.

Not only does firwood form the bulk of the imports, but it is also landed at so low a rate, that none of the other woods could replace it, were the supply of it to fall short. As bread is the staff of life, so are fir and pine the mainstay of all industries which work in timber. Hard woods, with the exception of oak, are more or less luxuries, the consumption of which can be reduced, without seriously inconveniencing the people of this country, but a falling-off in the supply of fir would certainly be a calamity.

Having thus indicated the relative importance of the several classes of timber, I shall now proceed to enquire into the safety or otherwise of future supplies. For this purpose I shall deal with the several regions whence the timber comes:

		£ value.
1.	Countries around the Gulf of Mexico, the Caribbean Sea, Mexico, Honduras, Columbia, Venezuela, West Indian Islands	450,689
2.	Gold Coast and Niger Protectorate	66,841
3.	Australia	65,771
4.	East India, Straits Settlements, Siam...	491,473
5.	Austria	63,582
6.	Holland and Belgium	181,278
7.	France, Spain, and Italy	693,173
8.	Countries around the Baltic—	

	Germany	£992,779	
	Norway	1,435,613	
	Sweden	3,977,607	
	Russia	3,970,492	
			10,376,499
9.	United States of America	2,356,827	
	Canada	3,552,477	
			5,909,304
10.	Other countries		124,931
	Grand total ...		£18,423,537

The countries around the Gulf of Mexico and the Caribbean Sea have sent us £450,689 in the shape of mahogany and other fancy woods. Of these countries the two most important are Mexico and British Honduras. Of the former I cannot give you any reliable information, but about the latter I propose telling you something, because I think an effort should be made to perpetuate and increase the supplies from this source.

British Honduras has an area of 4,096,000 acres, of which about 20,000 are under cultivation, leaving over four millions under forest and jungle.

The population is, I believe, under 40,000. The average annual imports from Honduras to Britain, calculated from the years 1890-94, amounted to—

	Tons.	£ Value.
Timber, chiefly mahogany	16,395	142,308
Logwood	15,680	123,433
Total	32,075	265,741

If I have understood the returns correctly, these imports correspond to some 97 per cent. of the total imports from Honduras to Britain, so that practically the very existence of the colony depends on them. And what has the colony done to preserve that export?

In 1885 the Colonial Office deputed Mr. E. Hooper, now a Conservator of Forests in Madras, to report on the forests of various West Indian possessions, and this is what that gentleman says as regards Honduras:—

"It is a prevailing belief in the colony that the supply of mahogany is not being reduced, and there is abundant proof of there being a large amount still standing; but unfortunately it is so far from the seaboard as to be utterly valueless under existing conditions of transport, and with the prices at present ruling. It is equally certain that the system of cutting among private mahogany venturers is decidedly tending to extirpate mahogany wherever accessible.

"Mahogany, although naturally distributed all over the country in the south of the colony, except in pine ridges, is at the present time only found far up the rivers. . . . With the removal of timber ten inches square, and every tree of larger

dimensions, there can subsequently be little or no reproduction, and unfortunately the tendency of the market is to require small wood—the mahogany being put to many more uses than formerly—so that there is little hope that cutters will respect undersized wood.

"The wood brought to the coast from the western district during recent years has been, on the whole, of larger dimensions, and it is certain that much large timber does exist in hitherto unexplored parts, measuring up to 72 inches square, and even more; but to find such large trees now one has to go to the frontier, whereas, from all accounts, similar trees have been felled and extracted within the century, in accessible places, whence there is at the present time only an export of small wood."

Mr. Hooper winds up by saying:—"All points, therefore, to the mahogany trade in British Honduras as having to pass through a period of serious depression, and it is questionable whether it will continue to be an important factor in the progress of the colony."

Mr. Hooper mentions that certain rules have been made to prevent the cutting of undersized trees (15 in. and under), but he states:—"If the Forest Clauses of the ordinance are calculated, at first sight, to protect the species specially referred to, as well as the forest at large, I fail to see how they can be enforced, unless precautions are taken to ensure their being respected. . . . From all accounts I understand that great laxity has prevailed hitherto in checking the cutting of mahogany. . . . If such a system continue, the ordinance, as far as forest protection is concerned, will be practically valueless."

As already stated the bulk of the exports of Honduras consists of timber. At the same time only about 20,000 acres are under cultivation, leaving upwards of 4,000,000 acres of forest waste land. If ever a case was made out for the preservation and careful management of the forests of any colony, it is for those of British Honduras. To allow matters to go on as in the past means the destruction of the exports of the colony, ending in financial and general ruin. By looking after the forests, on the other hand, exports might rise to several times the present amount, and be permanently maintained, especially as the available stocks of mahogany and logwood in non-British ports are sure to fall off as time goes on.

And here I should like to offer a few remarks on the present question in the West Indian possessions generally.

Mr. Hooper, in his reports on Honduras, Jamaica, and a number of the smaller islands, shows that in many of them, mahogany is indigenous, while it has been introduced into others, where it grows well. From many an export of logwood is carried on, but of timber proper little is exported. His opinion is that, in the case of all, the forest question deserves special attention and he makes various proposals regarding the management of the forests;

more especially he suggests that thoroughly competent forest officers should be be secured, adding that the smaller islands might share one of these. His proposals were reported on by the botanical advisers of the various Governments, and these invariably stated that the special forest officers were not wanted, as the heads of the Botanical Department could very well look after the forests in addition to their more legitimate duties.

Now, gentlemen, this is a mistake, and I shall tell you why. Botany is pre-eminently a science, which has led to the development of industries based upon the production of the land, while forestry is an industry in itself. No doubt it is an industry based upon science, as most industries in these days are, or ought to be. This has been set forth during the last few years in endless papers, pamphlets, and reports in connection with the development of the *trade of the United Kingdom.*

In the prosecution of an industry the economic point must always be pre-eminent, and this has, as far as I am aware, rarely been fully realised wherever a botanist has presided over the administration of forest estates. The business is not in their line, and as a rule they have not the time to follow up the intricacies of a practical industry.

At any rate the results in the British West Indian possessions have not been satisfactory. Here all energies have been devoted to the production of sugar and various other agricultural products. You also know that sugar, hitherto the most important of these articles, is being driven out of the market, and I fear that even the Commission which is now investigating the subject on the spot will not be able to arrest the rapid decline of this industry. In the meantime the income which may be derived from the forests of these possessions has, comparatively speaking, been neglected.

It appears to me that a strong effort is now called for to introduce a more rational system of management into these forests, by which the export can not only be maintained, but considerably increased as time goes on. For this purpose Mr. Hooper's advice should be followed, that is to say, competent forest officers should be engaged—say one each for British Honduras, Jamaica, and possibly British Guiana, while the smaller islands should engage one between them. The expenditure on such a measure is really trifling when compared with the interests at stake.

With competent advice at their disposal the Governments of the various colonies would soon bring the forests under proper protection and systematic management.

From Australasia we received in the year 1894 pinewood valued at £24,557; furniture materials, £40,648; house frames, £566; total, £65,771; total loads 12,222. This gives an average of £5 9s. 4d. a load. Since then a rapid increase of the imports has taken place. It is said that the value of the Kauri timber imported from Tasmania during the year 1896 amounted to the value of £270,000; while some of the Eucalyptus have come into

demand for street-paving blocks. I have seen it stated that the forests of Western Australia contain marketable timber to the value of £120,000,000. At the same time it must not be overlooked that Australasia, as a whole, is still an importing country, and that the timber imported into Britain from this source cannot be laid down at a low rate; hence there will certainly be a limit for the development of this trade. As to the manner in which the Australian forests are managed I have, on a former occasion (before the Royal Colonial Institute), given a considerable amount of details which showed that extremely wasteful methods prevailed. Later information fully confirms the opinion which I then expressed. Only two days ago the following extract from a Sydney paper came into my hands;—

"Unfortunately, in this colony, with, perhaps, one solitary and short lived exception, the Forest Department has never had the benefit of a competent head, with the natural result of its maladministration. Shifted about as it has been like a shuttlecock, out of one department into another backwards and forwards, and back again, under its ever-changing regulations, and ever regarded with an evil eye in Parliament, it has at last, under its present management, little vitality left in it, with the fast approaching consequence of the country soon becoming almost entirely denuded of its best timbers, when, undoubtedly, there will be an outcry when it is too late.

"That the heads of this department know so little of forest matters, and have not taken more interest in them, is much to be regretted; but what makes matters so much more serious is the policy of the Secretary for Lands which seems to be the cancellation of reserves and the alienation of some of our very best timbered country. This suggests the query: Does he comprehend the full import to the future of this colony of what he is doing? Be that as it may, such a state of things is being brought about in regard to our timber supply and forest area as is almost unprecedented in any other country, and is a reflection upon our intelligence, as it will, before very long, land us in serious difficulties, the fast approach of which urgently demands the independent and unbiassed investigation of a competent board of inquiry.

"At the present time the supervision of our forests (which was always inadequate) is little better than a farce, and is made quite subordinate to the inspection by the foresters of conditional purchases, while the forests are being devasted in the most ruthless manner. But what perhaps makes their (the forests') position, and consequently our timber supply in the future so much more critical and precarious is the fact of an uninformed public on such matters taking so little interest in them, while their representatives in Parliament are too often making political capital out of them in the propitiation of their consitituents—the timber getters—for whom, in exchange for their support, they are ever seeking further

concessions, while on their own part they act as though they had a special right to a monopoly of the forest to cut down and destroy, to suit themselves at their own sweet wills and pleasure, without let or hindrance of any kind."

Let us hope that the forests of Western Australia will not share the same fate as that which has overtaken the forests in the other Australian colonies. After all, the estimated stock of timber represents only six years' supply to Great Britain and Ireland.

As to the Kauri forests of Tasmania, they could not supply this country for even that length of time, apart from the fact that this pine timber could not be laid down at anything like the price of the pine which we receive from the Baltic and from Canada.

The next item on our list is the supply of teak and a moderate amount of fancy woods *from East India.*

A properly organised Forest Department was started in India in 1864. During the thirty-three years which have since passed an area of 72,000,000 acres of forest has gradually been taken under the management of the department, 48,000,000 being constituted under the existing forest laws as permanent forest estates. There are perhaps some 60,000,000 acres of private jungles, but these, not being under control, are deteriorating rapidly, and they can can only be relied on to yield in the future small stuff, fuel, grazing, and other minor produce.

The above mentioned Government forests must be relied on to furnish the necessary timber for a population of about 225,000,000 people, and for public works. But besides, they must yield large quantities of fuel, and especially of grazing, so important in times of scarcity, as at present, so that the total out-turn of timber, even under the most careful management, is not likely to rise above 2,000,000,000 cubic feet a year, which is equivalent to about 10 cubic feet a year per head of population. Hence the export from India will always be confined to teak and a number of fancy woods None of *these could be laid down in Britain under £5 load,* and most of them not at that. At the same time the management of the Burma teak forests has now been placed on such a basis that the quantities available for export will considerably rise as time goes on, thus relieving perhaps the pressure on other hard woods, if their supply should fall off.

And here I may add a few words about the financial aspect of the Indian Forest Conservancy. In 1864, when the Forest Department was established, the NET revenue of the department amounted to 678,000 rupees. Now it has risen to 8,000,000 rupees; and besides forest produce to the value of about 6,000,000 rupees is annually given from the State forests, *free of charge*, to the people, so that the total net profit from these estates amounts now to some 14,000,000 rupees a year. The

policy which has brought about these splendid results was originated by that great statesman Lord Dalhousie, sometime Governor-General of India, and I trust that the enlightened views which he held will ever be remembered by his successors. From time to time pseudo philanthropic views have threatened the operations of the Department with reaction, but fortunately the pendulum soon began to swing again in the right direction, and it is to be hoped that it will continue to do so.

Next to India and Ceylon the Cape of Good Hope has done most towards the introduction of a systematic management of its forests, and yet what do we fined there? According to information supplied by the Chief Conservator, the indigenous forest that once clothed the slopes of the Table Mountain Range has disappeared, with the exception of a few trees in the deepest gorges, where fire and axe could not reach them. To a great extent they have been, or are being replaced by plantations of exotic trees, such as the Cluster Pine (*Pinus Pinaster*), the Stone Pine (*P. Pinea*), the Oak (*Quercus pedunculata*), the White Poplar (*Populus alba*), the Blue Gum (*Eucalyptus globulus*), Red Gum (*Eucalyptus rostrata*), Kari (*Eucalyptus diversicolor*), Plane (*Platanus occidentalis*), pencil Cedar (*Juniperis Virginiana*), Pinus insignis, Pinus Canariensis, Jerusalem Pine (*Pinus halepensis*), Camphor Tree (*Laurus camphora*), American Black Walnut (*Juglans nigra*), American Ash (*Fraxinus Americana*), and Australian Wattles (*Acacia decurrens*, var., *mollis* and *pycnantha*, *saligna*, *glaucophylla*, *cyclopis*).

There is historic evidence that most, if not all the ranges of mountains for hundreds of miles inland were at one time clothed with beautiful timber forests of an evergreen, laurel-like character. According to the latest information there remain now—

	Sq miles.	Acres.
In Cape Colony	... 550	... 350,000
In Natal ...	... 259	... 160,000
In Zululand, about	... 75	... 60,000
Total	...	... 560,000

The whole of the 350,000 acres in Cape Colony is public property, in charge of the Forest Department. Under proper management they cannot be expected to yield more than 15,000,000 cubic feet or about 10 cubic feet per head of the present population. At present, however, they yield nothing like this amount; hence the Cape has imported of late years, on an average timber to the value of £160,000, of which two-thirds are pine and fir timber; and the plantations which are now being made consist chiefly of such species, principally cluster pine

Of the 160,000 acres of Natal timber forests, more than three-fourths have been alienated, and are being rapidy destroyed.

As far as authentic information goes, the wooded areas in the Transvaal, Bechuanaland, and Mashonaland are, as timber forests, of secondary importance, the trees being usually of stunted growth and excessively hard.

To sum up, it may be said that the Cape Colony and Natal have not enough timber for their own consumption, and they are not likely to be in a better positon for many years to come, for the growth of forest trees is slow.

It is interesting to notice that the Chartered Company of South Africa has already established a Forest Department, but as far as our scanty information goes at present, it will be as much as that Department can do to provide the Colony with timber, and in all probability it cannot do that much.

In Rhodesia the forests are described as little better than scrub in the plateau country; in the low lands the forest is said to be better, but very unhealthy. Proceeding now to European countries, we find that Austria sent us 6,787 loads valued at £63,582, making an average of £9. 7s. 4d. a load. The timber consists chiefly of oak, and Austria could probably send us more than in the past, but as the price is high, I do not expect much increase in the quantity.

France, Spain, and Italy send us timber to the value of £693,173 which is valued at 18s. 4d. a load. By far the greater part consist of pit timber, which comes from the country bordering on the Bay of Biscay. Here France has reclaimed, since the close of the last century, an area of some two million acres, which used to be a waste of shifting sands and swampy ground. A large portion was planted with the cluster pine and from these woods we now receive considerable quantities of pit timber. As far as I can judge this supply may continue, but it cannot increase beyond a moderate extent.

As regards the receipts from Holland and Belgium, they represent a fraction of the timber imported by these countries.

And now I come to the most important part of my subject, the supplies which we receive from the Baltic and from North America, namely, Canada and the United States. By reference to the figures previously given, it will be seen that we received in 1894:—From the Baltic, £10,376,491; from Canada and the United States, £5,909,304; making a total of £16,285,795. Here, then, we have to do with the *bulk* of the imports into Britain, £3,552,477 coming from Canada, and £12,733,318 from foreign countries. I shall first deal with the supply from the Baltic.

Germany has sent us timber to the value of £992,779. Of the forests of that country 51 per cent. are either state forests or under state control, and they are managed systematically, aiming at a sustained yield. At the same time Germany imports already more timber than she exports. Her population is in-

creasing rapidly, and her trade expanding at a great rate, hence she is likely to require, within a reasonable period, every stick of timber which she produces. At any rate, any export must be made good by a corresponding import from elsewhere.

As to Russia, Sweden, and Norway, it cannot be said, at present, that the forests are worked with a view to a permanent supply. You will observe that Russia sent us £3,970,000 of timber ; Sweden, £3,977,000 ; Norway, £1,436,000 ; making a total of £9,383,000.

Of the Russian forests 60 per cent. are said to be State forests, of those of Sweden 20 per cent., and of Norway 12 per cent. The State forests are more or less under systematic management in Sweden and Norway, but the percentage is small. In Russia matters are less advanced. There seems to be no doubt that a falling off in the size of the timber is noticeable, which indicates that the accessible forests at any rate have been overworked. Hence more distant forests, especially in Russia, must be attacked as time goes on, and this will gradually raise the price per ton at which timber can be delivered in Britain, if it does not indicate a prospective decline of the quantity available for export. Besides, it must be mentioned that an enormous industry of the manufacture of paper pulp has lately sprung up, especially in Sweden, which uses small trees, in other words the trees which ought to replace those now cut for export as timber.

As a consequence all the private forests in Sweden and Norway, and they form the bulk of the whole, are being rapidly reduced in material, and in Russia large areas of forest are every year sold wholesale for cutting.

Again, the countries around the Baltic supply many other countries, besides Britain, with timber, such as Denmark, Holland, Belgium, France, Spain, Italy, Portugal, Gibraltar, Algiers, Egypt, Tunis, Morocco, Greece, Asia Minor, Cape Colony, Natal, other parts of Africa, Australia, Brazil and La Plata.

I think I am within the mark when I say that the total exports from the Baltic are more than twice the amount which is sent to Britain. All that timber represents the produce accumulated during the last century or two. On the whole I have no hestitation in saying that the up-keep of the supply from the countries around the Baltic is considerably more than problematic. What with cutting the matured trees for export as timber, and the young growths for the manufacture of paper pulp, stocks available for export must come to an end sooner or later.

From Canada and the United States we have received : from Canada, £3,552,000 ; from the United States, £2,357,000 ; total 5,909,000. is this supply assured to us?

With a view to answering that question, I shall first offer a few remarks about the the United States :—

I gather from a report drawn up by the head of the Forestry Division and signed by the Secretary of Agriculture, Washington, dated 10th February, 1896, that the forest area of the United States (exclusive of Alaska) has been placed at 500 million acres, and the annual consumption of wood at 25,000 million cubic feet, or 50 cubic feet per acre per annum. Such a yield can only be expected permanently from forests which are systematically and skilfully managed, and which are not over-run by forest fires. Considering that all these conditions are totally absent in the United States, it is clear that the people of that country take far more out of their forests than is made good by the annual new growth; in other words they are hurrying towards the exhaustion of their stock.

The seriousness of the situation has been felt lately, and on the recommendation of a special Forestry Commission, Mr. Cleveland has, a few days before surrendering the Office of President, declared an area of 21,000,000 acres to be State forest reserves. This, added to previous reservations, makes a total area of 39,000,000 million acres, which after all, is less than 1-10th of the area required to supply the present population of the United States.

The above-mentioned report mentions further that the imports and exports of timber of the United States have just about balanced of late, so that country is not a genuine exporting country at all. As a matter of fact, is has made good its exports by imports from Canada, and this is the point which interests this country. The imports from Canada, to the United States have increased most rapidly of late years. Whereas in 1889, of the timber exported from Canada, 61 per cent. went to Britain, and about 39 per cent. to the United States; the position had been reversed in 1894: 40 per cent. having gone to Britain, and 90 per cent. to the United States.

In fact, the United States import already twice as much timber from Canada as they send to Britain. This process is increasing so rapidly that, after the lapse of a limited number of years, the United States are likely to require every stick which Canada can spare under present conditions, thus threatening to cut our supplies short by some £6,000,000. And thus we have arrived at the Dominion of Canada. On reference to

Table III.

ESTIMATED AREA OF THE WOODLANDS AND CANADA.

Provinces.	Area of Woodlands in Square Miles.	Percentage of Woodlands to Total Area.	Population in 1891.	Area for Each Head of Population. Acres.	Revenue Derived by Government in 1893.
					£
Ontario ...	102,118	46	2 114,321	31	379,574
Quebec ...	116,521	51	1,488,535	50	178,353
New Brunswick	14,766	53	321,263	29	39,282
Nova Scotia ...	6,464	31	450,396	9	...
Prince Edward's Island.	797	40	109,078	5	...
Manitoba ...	25,626	40	152,506	107	...
British Columbia	285,554	75	98,173	1,885	15,196
Territories ...	696,952	29	98,967	4,506	...
Miscellaneous ...	...	...	...	...	31,381
Total ...	1,248,798	38	4,833,239	165	643,786

Table III., prepared from the Canadian Statistical Year Book, you will observe that the areas of forests in that country are given as follows :—

	Square miles
Ontario	102,118
Quebec	116,521
New Brunswick	14,766
Nova Scotia	6,464
Prince Edward's Island	797
Manitoba	25,626
British Columbia	285,554
Territories	696,952
Total ...	*1,248,798*

Here, then, you will think at first sight are areas sufficiently large to supply all our needs, besides making good the deficiency of the United States. On closer investigation, however, it will be found that a considerable portion of the area, though classed as woodlands, does not contain any marketable timber, and that the rest is by no means taken care of in such a manner as to secure a permanent supply of timber. On these matters Mr. George Johnson, the statistician of the Dominion, gives us much interesting information in his "Report on the Forest Wealth of Canada"—The forests of Canada contain a considerable number of species, such as firs, pines, larch, oaks, maples, plane, birch, hickory, ash,

walnut, poplar, elm, etc. Of these the three most important are :—(1) The white or Weymouth pine (*Pinus Strobus*). (2.) The spruces, especially (*Picea alba and nigra*). (3). The Douglas fir, or Oregon pine (*Pseudotsuga Douglasii*).

The white pine appears only in the south-eastern part of the Dominion, over an area of about 70,000 square miles. Its timber used to be the principal item in the export, but not only the quantity but also the quality has fallen off. Whereas the export in 1865 amounted to 606,300 loads, it has fallen to 105,789 loads in 1893, being a reduction of 82½ per cent., although the average price rose during the same period from £1 a load to £2 16s.

Mr. Johnson further shows, from measurement made at the ports of export, that the average size of the logs has fallen off by 30 per cent. during the same twenty-eight years, and he naturally arrives at the conclusion that the first-class quality white pine has nearly disappeared. The question has been asked, whether the new growth will not replace what has been cut away. On this point we have only the vague assertion that of the second quality pine there is a considerable supply. From a recently published work by two American gentlemen, Messrs. Pinchot and Graves on the white pine in Pennsylvania, it appears that a reduction in size like that indicated by the above-mentioned measurements corresponds with the increment of sixty-eight years on the localities of middling quality, and of forty-four years on the very best localities.

Even the most sanguine estimate put forward in Canada is to the effect that the existing stock of white pine will be exhausted in thirty-seven years ; but from the data which I have given it is clear that this will occur very much earlier.

Not only have the white pine forests been worked at about twice the rate of annual increment, but for every tree which has been cut some ten or more younger trees have been killed by fire.

Turning now for a few moments to the spruce and Douglas fir, it should be stated that they appear over very extensive acres.

Enormous quantities of spruce timber are said to exist, but its cutting has also very much developed of late. As regards Ontario, it is stated that "its increasing use for the manufacture of wood pulp, largely for export, threatens serious inroads upon this valuable tree." Again, in referring to Quebec "the spruce forests of Quebec are said to be very rich and extensive, and are being more and more exploited every year, adding a constantly growing proportion to the exports."

It appears that the spruce is gradually taking the place of the diminishing white pine, and that with lumbering and the manufacture of wood pulp, it is likely to share its fate as time goes on, at any rate within reasonable distance of the lines of communication.

The Douglas fir has its home in British Columbia, spreading eastwards into Manitoba. It is the most important timber tree of

that region, growing abundantly and to an enormous size on Vancouver Island, on the mainland shore, and in places extending inland. This tree is the main object of the lumbermen; besides domestic use, it is exported to the United States in rapidly increasing quantities, being widely known in commerce as "Oregon pine."

It is also exported to many other countries, and even as far a South Africa, where it is much used as pit timber. As regards this country, the Columbian timber is much less importance than that which comes from the eastern provinces of Canada, because the cost of transport is much higher. I have lately seen it stated that the freight came last year to 63s. and 66s. a ton, which is nearly twice the amount at which fir timber can be laid down in British ports from the Baltic and Eastern Canada.

Owing to the rapidly increasing requirements of the United States, however, I fear that this third great tree's existence is not on a safer basis than that of the others. At any rate, I think I have said enough to show that the Dominion of Canada should take early steps to preserve this important article of export amounting to 25 per cent. of its total exports. Let us see, then what Canada has do..e up to 1895 in this direction.

I do not think I need do more than shortly mention what has been done in Quebec and Ontario to check destruction and to assist the reproductive forces.

In the province of Quebec the legislature, by Acts passed in 1883 and 1889, has divided the province into twenty-one fire districts within which the Commissioner has the power to employ the necessary number of men to act in the suppression of any forest fires. For this purpose the Government has set aside the magnificent sum of $5,000 (£1,000) and the licence-holders are obliged to contribute a similar amount to cover the expenses incurred.

As the total area of forest and woodland is given as 116,521 square miles, each fire district comprises on an average 5,550 square miles, scattered over about 10,000 square miles, for the protection of which £95 are available every year. I need hardly say that under such condtiions protection can exist only on paper.

In addition, licence-holders are prohibited from cutting pine trees measuring less than 12 inches, and trees of any kind less than 9 inches on the stumps; but it is nowhere stated how this prohibition is enforced.

Ontario, also, has a Fire Act, which empowers the Lieutenant-Governor in Council to proclaim fire-districts, within which fire from 1st April to 1st November, must be most carefully handled. For instance, for cooking, warming, or for any industrial purposes, selection must be made of a spot with the smallest quantity of inflammable matter, which must be removed for a radius of ten feet.

Fire rangers have been appointed since 1885, and in 1891 there were 91 of these, which entailed an expenditure of £4 000. In some years, it is reported that no fires occured, but in 1891 there were bad fires.

A forest reservation and national park has been set spart in the Nipissing district called the Alaquin Park, but alas, two-thirds of it were already under licence, and on the remaining third the pine lumber was sold in 1892, so that this tract will not have the advantage of being a reserved forest under State management.

With all due respect to the Governments of these provinces, these measures can only have an infinitesimal effect upon the preservation of the forests, if they have any effect at all.

There is ample evidence to show that the measures of protection in Canada fall far short of what is wanted. Mr. Johnston, in his report, says :—

"A large portion of the forest has been divided (which I understand to mean that all the great trees have been cut out) by the lumbermen seeking for marketable timber. The careless torch has lighted fires like the Miramichi fire, which swept with fierce energy over an area of more than three million acres (4,700 square miles), leaving blackened giant pines to be a reminder, for more than half a century, of the immense destruction there and then caused. , . . Vast acres have suffered from fire so severely, that in many places the soil has been burned off to the very rock; and a century's disingrading force will have to act upon the rock before there can be soil enough created for practical uses."

In another place Mr. Edwards M. P., said in 1893 :—"It is safe to say, and I am sure that every lumberman in this House will bear me out in the statement, that *ten* times the amount of forest wealth has been destroyed in Canada through forest fires, than has been cut by the lumbermen."

The conclusions which Mr. Johnston arrives at, in summing up the reports from the various provinces, are as follows :—

1. That the first quality pine has nearly disappeared.
2. That of the second quality pine there is a considerable supply.
3. That of other timber there is a large supply.
4. That Canada is within measurable distance of the time when, with the exception of spruce as to wood, and of British Columbia as to provinces, Canada shall cease to be a wood-exporting country.

If these conclusions represent the actual facts, and I have no reason to think that they do not, then the Dominion of Canada is face to face with a very serious state of affairs, which requires immediate and prompt action. There can be no doubt that proper forest conservancy should be introduced at a very early date, and before it is too late. This is necessary not only for the comfort of the present population, but also to meet the requirements of a future increase, and to satisfy the export trade in timber.

The matter is most urgent in the maritime provinces, where comparatively small areas are now at the disposal of Government. But even in Quebec and Ontario no time should be lost, as the difficulties will increase with every year which passes without action being taken; while in Columbia a great national industry may be preserved and immensely developed, if early steps are taken.

And how should the Governments of the various provinces proceed? The answer is simple enough. Apart from the general supervision of the forests still at the disposal of Government, a sufficient area should, under an adequate forest law, be selected and constituted as permanent forest estates. These should be thoroughly protected against fire and unlawful cutting, and they should be managed with a view to increasing production and a sustained yield, somewhat on the lines which have been followed in India. No doubt strong opposition would be offered to such measures, especially by those interested in the timber trade, but these difficulties can be overcome, just as has been the case in Burma, where the late Sir Arthur Phayre and Dr. (now Sir Dietrich) Brandis laid the foundation of a systematic management of the teak forests. Besides the measure is not so difficult to carry into effect as would appear at first sight.

According to the "Statistical Year Book" of Canada, the total cut in 1893 amounted to 1,400,000,000 cubic feet for home consumption, and 600,000,000 cubic feet for export, making a total of 2,000,000 000 cubic feet. To secure this supply permanently an area of about 110,000 square miles is required, and this is, after all equal to only about 9 per cent. of the total area of woodlands, leaving 91 per cent. for the ordinary lumbering operations. By way of further illustrating the matter, I may take the case of the Provinces of Ontario.

Ontario has a forest area of 102,118 square miles. During the seven years (1887-93) the average annual cut on the Crown lands amounted to about 66 000,000 cubic feet, yielding a value of £277,615 To yield this timber under efficient management an area of about 5,000 square miles would be required, which represents about 5 per cent. of the total forest area, or 2½ per cent. of the province. The administration of these 5,000 square miles would cost about £35,000 a year, or 12½ per cent. of the annual forest revenue. If an area of 10,000 square miles were declared permanent forest estates, thus securing double the present cut, the cost would amount to £70,000, or about 25 per cent. of the past annual income derived from the forests. There would still be a forest area of 92,000 square miles, where lumbering could go on as before.

Similarly, in Quebec 10,000 square miles might be declared reserves, leaving 106,000 square miles for the ordinary timber operations, and so on for the other provinces.

At the same time, these reserves would not be altogether closed against cutting, but that operation would be performed with

due regard to the future yield capacity of the area, so as to step in and supply the country and the export trade at twice the present rate when the remainder of the forests commenced to give out.

The Dominion of Canada consists of a number of self-governing colonies, and it is not for me to say in how far the Home Government can influence that of Canada, but I am convinced that the matter is one of great importance. The wages now paid in Canada for timber work are estimated at £5,000,000 a year, and the capital invested in the trade is given as £20,000,000. These are sums not to be trifled with, especially if it is considered that they might easily be doubled and trebled as time goes on, provided a sensible view is taken as regards perpetuating the supply of the raw material. Indeed, Canada can become the great emporium for the supply of timber for the whole world in the same degree as other sources of supply fall off.

Returning now to this country it is clear, on the whole, that future supplies of timber rest on an unsafe basis. Most of the oak timber might, no doubt, be replaced by other hard woods, but this is out of the question as regards the pine and fir timber. The latter is now laid down on these shores at an average cost of £1 18s, 8d. a load, and none of the colonies except Canada can supply it at anything like that rate, even if they could grow the timber. Hence the systematic management of a fair proportion of the Canadian forest is of the utmost importance to this country.

But cannot we do something at home to assist in the production of timber? This opens out a question which would require a separate lecture for itself; hence I can only lightly touch upon the subject on this occasion. The agricultural returns show that we have in Great Britain and Ireland, mountain land and heath land used for rough grazing, 12,000,000 acres; land not utilised at present for agricultural purposes, about 13,000,000 acres; making a total of 25,000,000 acres. Most of this land is, of course, used for shooting, and yields in this way, apart from rough grazing, a certain return, but I do not see any reason why a considerable portion of it should not be put under timber. It is said, in answer, that it does not pay to plant, but it is also easy to show that it will pay if the thing is done properly.

If hitherto home-grown timber has not been able to compete with imported timber, the reason must be looked for in the following two facts:—(1) The home-grown timber is of inferior quality; (2) it comes into the market at irregular intervals and in fluctuating quantities. These drawbacks can, however, be removed by improved sylvicultural methods and a more systematic management of the forests, a subject with which I have dealt on various previous occasions. It is, indeed, easy to show that land which does not let for more than eight shillings a year—and there are many millions of acres—

can be more profitably used by afforesting it, even if all calculations were made with compound interest on the outlay. The question of extended afforestation in these islands, and especially in Scotland and Ireland, has lately come more and more to the front, and the President of the Board of Agriculture has been approached on the subject of giving assistance. The question then arises, What can be done to stimulate the afforestation of surplus lands?

The difficulties in the way are :—

1st. That afforestation requires a certain outlay at starting, and involves foregoing an income, however moderate, from the land until the woods commence yielding a return.

2nd. That a more complete knowledge of systematic forestry is required by those engaged in the formation and management of woods worked on economic or commercial principles.

Hitherto these matters have practically been left to private exertions but since agriculture has fallen low, many names (including those of heading men of journals) have been calling upon the State for assistance, not only in this respect, but as regards industries generally.

Although the proprietors of the land are those most interested in the matter, I think some assistance by the State is called for in this instance, and it might be given in one and all of the following ways :—

1. Assistance should be afforded for the equipment of forest schools, where economic forestry, as now elaborated by research, can be taught.

2. The Crown forests should, as far as they are not required for other purposes, be managed on economic principles, so as to serve as patterns to private proprietors, and as training grounds for young foresters.

This is a matter which has been urged by myself and others for the last 30 years. It was gratifying to me to hear only a few days ago, that H. M's Commissioners of Woods and Forests have at last made up their minds to do something in this direction.

3. Advances might be made to landed proprietors at 2½ per cent. interest for the purpose of planting surplus lands, if they are unable to raise the money otherwise.

4. Under certain conditions surplus areas might be acquired by the State and put under forests; this would especially apply to the congested districts of Ireland.

This budget of suggested methods of helping is not very formidable, and I think it is quite worthy of attention on the part of the Government. A modest amount of help in the direction just indicated may :—

1.. Produce a not inconsiderable benefit to agricultural interests.

2. Help to secure a permanent supply of timber to these Islands.

3. Be the means of keeping in this country a large sum of money, instead of sending it abroad every year ; and

4. Last, but not least, provide additional work for the ever-increasing population of the country, help to prevent the continuous flow of population from the country into the towns, where only too many are forced to swell the army of the unemployed.

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Shade, Cover, and Shelter.

The term "cover" is in frequent use, as also are the words shade and shelter, in a more or less indefinite sense. "Cover" and "shade" have their definitions in our books, but hitherto the tripartite degree of precision has perhaps not been clearly seen. In fact, it is not always possible to differentiate the effects which fall under the above heads, but nevertheless they are in many important cases capable of individual recognition. It is to be recommended then that in alluding to these matters, foresters should first ascertain precisely whether they mean "shade," "cover," or "shelter," and speak accordingly. M. E. Guinier has contributed to the Revue des Eaux et Forêts his conclusions on the subject, and for the benefit of our numerous readers who have not access to them in original, the more important points, and others more nearly concerning us, are touched upon below.

First, then, the definitions. A definition is to an idea much the same as a crystalline form is to a mineral. It happens frequently that the idea, and the mineral, though quite distinct and recognisable, have no crystalline form, which fact is, perhaps, on the whole, something to be thankful for, as encouraging reason versus cramming.

Cover is the existence, and action, of a more or less opaque screen between the soil and the zenith. Its effects are seen within the horizontal projection thereof on the soil, that is to say vertically beneath every part of it.

Shade is the action of a more or less opaque screen interposed between the sun and the soil or plant. The shadow of this screen moves with the sun, and its effects vary according to the time during which, and the direction from which, direct sunlight can pass it.

Shelter is the action of a screen more or less impermeable, and more or less extensive, placed between the plant or soil, and the horizon or other part of the sky, at a distance sometimes considerable.

In its widest and most general sense, the term "shelter" includes the other two, which are only particular cases thereof.

I.—*Cover.*

Cover, if complete, is always harmful. It would be impossible to grow plants under a solid wooden roof large enough to prevent access of sidelight, and even under a dense high forest it is found that the underwood is little or none.

Certain plants can accommodate themselves to sidelight only, but others (*e. g.* mignonette, indoors) can not.

The action of cover is thus greatly dependent on its area, which limits the amount of lateral light that can obtain access. An isolated tree frequently does little or no harm, while a dense high forest only allows any undergrowth to appear in the richest and most fertile spots. Over crops of corn, &c. if the soil is good and the trees tall and scattered, little harm results, either to the quality of the crop or to its ripening.

The action of "cover" is modified by the degree of moisture in the air, for the following reason. Sunlight is of two kinds, direct and diffused, the latter being the light reflected in all directions by the atmosphere, by the particles of moisture, by the dust floating in it, &c. The presence of mist or of thin films of cloud, may even as much as quadruple the light, not indeed of the sun, but that of the sky in general, since the direct rays are impeded and absorbed. This diffusion of light attains its maximum in an air saturated with moisture on the point of condensation. Foresters in this country will surely be able to remember days when the sun was veiled, but the sky so intensely bright that the eyes were dazzled more than by the direct sunlight itself.

Moisture in the air affects also the heat, since both in the invisible and in the visible (mist) state, and especially at night, it intercepts the heat radiating from the soil, and so prevents the lower layers of the atmosphere from becoming cold. An important consequence is this, that in moist places or countries, whether foggy or clear, the layer of air in contact with the soil is warmer than is the case in dry climates. This is the case even under the cover of a High Forest.

The gases emanating from the soil, the scents of flowers, resinous vapours, &c, often appear to influence heat more even than does the moisture. The stifling heat of a pine forest on a hot summer day is probably due to the vapours of resin.

The special effect of a moist atmosphere is, that the light varies less, as from cover to open; there is less difference between the light under "cover" and the light in the open, than in dry climates. In a moist atmoshpere, protected from direct sunlight,

the differences between the temperatures communicated to the soil and to the plants are less extreme, and the temperature of the air in general is more equable.

In misty or foggy climates, the injurious action of "cover" on the vegetation is further diminished by the fact that the chemical or actinic rays which form part of all sunlight, are present in greater relative abundance in a weak light, and are very plentiful in diffused light.

It is true that the air contains more moisture as the equator is approached, but it is much more thoroughly in solution, so that in fact the most cloudy skies and misty climates are found under more northern latitudes, for example northern France and Germany. In such climates other circumstances being equal, the light under the cover of high forest is relatively greater than the average, and the warmth of the soil is better preserved than usual. It is a mistake to say that the absence of mist, by intensifying the brilliance of the light, permits light-demanding species to survive under cover to a certain extent.

The above explains the fact that in northern climates such as Norway, the broad-leaved species give a more dense shade and cover than the same trees further South. It also explains why certain species (*e. g.* birch), extreme light-demanders in France and Germany, can yet bear a certain amount of cover in Norway.

The fact is, that the climate being more misty, the light is more diffused, and thus penetrates more easily under the cover, causing buds to develop more easily in the interior of the crowns, and lower branches to remain green longer. M. Guinier goes so far as to say that the conception of the classic seed-felling called "close" or *coupe sombre*, could only have arisen in such a climate (N. Germany) where the influences above considered enable young plants to survive and develop under an amount of cover that would be soon fatal to them in a brighter and drier clime.

There are other ways in which the action of 'cover" is hurtful, for instance by preventing the formation of dew and the access of light rain to the soil. More fanciful perhaps are the effects resulting from the green colour of the light filtered through the crowns, (green being a color unfavourable to vegetation) and the problematical abstraction of electricity by the dominant species.

"Cover" has also its utility. It protects against too much insolation those species which can live under another. It prevents too rapid transpiration. It avoids sudden and violent chills at night. It improves the soil by assisting decomposition and keeping it in a light and moist state undeteriorated by sun and wind.

II.—*Shade.*

Shade, whether produced by trees, hedges, walls, or near hills, is not harmful as a general proposition, for there is a large class of shade-loving plants which absolutely require a shade more

or less dense and more or less enduring. Shade is hurtful to agricultural crops, to market gardening, and to the growing of fruit and flowers, subject to a few exceptions which require a small amount of shade. In forestry, shade is considered generally an advantage, but with a certain degree of reserve. Shade moderates transpiration, mitigates insolation, diminishes evaporation and preserves the freshness of the soil to a considerable extent, while it prevents neither the deposition of dew nor the access of light rain, nor does it interfere with the functional activity of the chlorophyll. It may, on the contrary assist this latter, which is sometimes hindered by too strong a sun. In short, shade is hurtful or beneficial only according to circumstances, as may be seen plainly in any forest nursery. Sometimes a bed of plants in the open is killed off, while a bed that happens to be shaded for an hour or two in the day may thrive. Sometimes the growth of the plants is seen to vary directly as their distance from a hedge or bank or other shade producer, the level of their crowns producing a perfect inclined plane. Sometimes the young plants put out in a blank will prosper only round the borders, sometimes only in the middle. The former is sometimes markedly the case with *Sal*.

The shade of standards over coppice appears generally favorable to the stoolshoots, but in this, as in most other cases, it is difficult to separate the benefit derived from shade and that derived from shelter.

III.—*Shelter*.

Shelter, when it involves neither shade nor cover, is always beneficial, whatever the crop affected, but especially in the case of fruit and flowers. Sheltered positions are generally rich in species. Even natural forest, growing in difficult conditions, can only subsist in sheltered situations. Shelter indeed modifies favorably all the conditions of local climate, sometimes even altering it completely. There are two kinds of shelter. As we have geographical climate and local climate, so we may have geographical shelter aud local shelter.

Geographical shelter depends on the configuration of the soil, and especially on the existance of high mountains.

Local shelter depends on the minor elevations and depressions of the soil, small spurs and ravines, and on the works of man himself, such as hedges, lines of trees, walls &c.

Geographical shelter acts by reducing the strength of the wind, or changing its direction and its temperature, and consequently that of the soil. It also influences the conditions of storm, rain, and fog. In cold climates, shelter from the north wind is desirable. In hot dry climates, shelter from the south may enable vegetation to exist where otherwise would be bare rock. The vine for instance, about Grenoble is hardly cultivated at a greater elevation than 1,600 feet, while in the valley of the Durance, vineyards are found at nearly 4,000 feet. The same conditions affect the

forests also, and probably to an even greater degree. Even when the mean temperatures are the same there is a great difference in the solar radiation at high and low altitudes, especially if comparison is made between a high situation in the South, and low one in the North. In the mountain, the air is dry, fogs are rare, the number of clear days is greater, and the sun's action is both stronger and more prolonged. Hence the vegetation is more active and the plants get through their development in a shorter time. One effect of shelter is the limitation of the sky area towards which radiation can take place, and the consequent diminunition of the nightly cooling to which the sheltered spot is subject.

Another effect lies in the radiation which it receives. Suppose a spot sheltered from the North by a high slope. This slope receives the sun's rays more or less at right angles to its surface, and so reflects back a large proportion of them on to the place shelterd by it. If sheltered from the South, it would be by a slope facing North, which could possess no great heat to add to that received directly from the sun. In general terms, the East is the aspect most favorable to vegetation, the South and West the worst, but it must never be forgotten that the local has a powerful influence on the general, and may in some places nullify it completely.

The action of wind is always inimical to vegetation, not only by the excessive evaporation and cooling which it causes, but by its mechanical action, which produces crooked, stunted, distorted stems and branches, together with heart shakes, ring shakes, and other evils. These effects can be seen anywhere along the seashore and on exposed crests and ridges. Remarkable exceptions to this rule are found in the *Pinus cembro*, always erect, sturdy, and dignified, and to a less degree in the Lombardy poplar, which is never known to grow crooked, though it is indeed not subject to such violent trials as *Pinus cembro*. Constant and violent winds leave their impress on the trees, which are not only all sloped in the same direction, that of the wind, but show many dead branches on the exposed side, and possess trunks not circular but oval (not elliptical) in section, the thick end of the oval being on the sheltered side.

Local Shelter. The Indian peasant, and the large landowner are agreed in waging war to the knife against all trees growing round or scattered in their fields, unless prevented by the fact of those trees being " royal," or Government. Even then the trees lead a sometimes precarious existence. The reason is, to a small extent, the desire of gain, and the need of wood for household purposes, but chiefly the destruction is due to a belief that the presence of a tree, or even a hedge, injures the crop. In Europe, on the contrary, it is generally recognised that fields sheltered by rows of trees are more productive than those that are not so sheltered, and when the demand for wood has exterminated the trees, it is not uncommon to find farmers sheltering their fields

on the exposed side by fences of different kinds. The exposed side of course depends on the danger, frost, dry winds, scorching sun, whatever it may be, in conjunction with the demands of the crop. The shelter given by a wall, tree, ridge, etc., extends to a distance of 10 to 20 times its height. At high elevations, the upper borders of the forest should be preserved with the most extreme care, the trees once removed, whether by abuse of rights or by accident, can never be replaced, and there is a phenomenon only too familiar which may be called the *lowering of the forest zone.* The upper shelter once gone, exposes a lower band of forest which is unable to resist the new conditions and disappears. This again exposes another band which disappears likewise, until the forest limit descends to a level where it can subsist without shelter. An article, published sometime ago, referring to this subject, mentioned known instances in which abusive grazing had lowered the upper edge of the forest zone by (if memory serves) 1,000 to 3,000 feet. The graziers themselves would perhaps not make the least pretence of regret, the grazing lands lying mostly above the forest, but every forester knows what it means to have another 1,000 feet of bare steep slopes exposing the country below to all the dangers of landships, torrents, avalanches, an increased severity of climate.

Is shelter ever harmful? There are two cases in which this may occur. Occasionally a place is found sheltered from the South, when all it happens to want is a little more sun. Frequently places are found where plants are habitually killed off by frost, though the surrounding slopes suffer in no such way. These are well known, and consist of valley bottoms, small depressions, and little level places where the plants put out are killed back year after year till they attain a height of 6, 10, 15 ft. as the case may be in the locality, when they are safe. The reason of this danger lies in the fact that such places are more moist, and more protected from wind; it is the presence of moisture (which would be carried off by a breeze that constitutes the danger of frost. Another reason doubtless acts to some extent, namely the gravitating of the coldest (*i. e.* heaviest) air to the low levels and depressions where it can effect a lodgment. There are certainly other reasons, for this question of local frost is not completely understood.

IV.—*Minor flora.*

The minor flora found in a forest differs in the same locality according to the density of the shade and cover, Under a very dense cover, such as that of a young spruce crop, there is absolutely nothing to be found, unless a few fungi, lichens, and perhaps a moss or two. As the cover becomes less, a few phanerogams appear, and the list increase with the light, until the forest, consisting of scattered trees only become a perfect paradise for the botanist.

V.—*Regeneration.*

How are the seedlings produced under cover? How do the young plants develop? That is to say, what are the conditions of regeneration of a given species? These are the questions which claim the attention of every forester, and cannot be urged too frequently. Practically every forest species scatters every year a certain amount of seed. What becomes of it? Are seedlings found to correspond? In some cases can even a single seedling be found? Can we even say that we know by sight the young seedling of every species? Can we tell when and where to look for it? How to obtain it? How to treat it when obtained? A few eminent foresters may consider these questions derogatory to their dignity. To such they do not apply, but let them serve to point out a wide sphere of usefulness to those in search of a direction for the better exercise of their energies.

Suppose we have a good crop of seedlings under a silver fir forest which is to be regenerated. Do we think we have got what we want, and proceed to clean-fell all the mature trees, rejoicing? Or, do we proceed to make a careful selection felling, and yet another and a third, watching the result with some anxiety, and taking 10 or 20 years over it?

In a chir forest naturally open, when regeneration is wanted, we clean out half the stock or more, straight away, and the rest follows five or six years after. Why this difference? Because trees have different temperaments and requirements, which are classified as "delicate" or shade-enduring, and "robust" or light demanding. But having provided these two labels, we must not imagine we know all about their use. Some trees will require both, at different periods, others will not be fitted with either, and others, it must be confessed, have not been properly measured yet. A great deal, (but yet far from everything) is known about teak, deodar, spruce, sal, blackwood, babul, &c., but of how many of the important auxiliary species can the same be said? Referring to babul, it is sometimes alleged that it will not grow on a calcareous soil. Any forester able to quote actual instances of a good crop of babul growing on a soil calcareous proper, would be doing a service. Such instances should be easily found in Sind, and elsewhere.

In so far as concerns the power of resistance to the solar rays, it may be said that nearly all trees are at first, for a very variable period, and to a varying extent, "delicate." In fact, instead of asking whether such and such a tree is robust or delicate, we might almost as well ask *when it began to become robust.* To take deodar for instance, it is well known that for the first year or two, or three, the plant is decidedly delicate, becoming less so for the next ten years or so, after which it is as robust as can be desired, for we find it, densely branched to the ground, crowning dry ridges and pinnacle rocks in solitary and sturdy grandeur. Young

plants that are of a somewhat herbacceous habit, and those that are naturally slender, are generally delicate, but others, (*e. g.* silver fir) remain so long after the period of lignification has set in. Some young plants, while still appearing slender, will become robust within a few months of germination. There is a certain relation between the density of the cover of a given species, and the temperament of the young plant. The law of the survival of the fittest makes it evident that this must be the case for some of the dominant species, but what about those species which may be called "opportunist," auxiliary and accessory species, even minor principal species, that seldom form the mass of a forest, but have to come up, survive or perish, just when and where they can? For these, there is no such law, and they form the majority. The spruce is an exception to the general law, its seedling is less delicate than that of the silver fir, while *its cover is more dense.* The difficulty is solved by the lightness of its seed, which is carried beyond the actual cover.

But the sun is not the only danger. Plants that can endure the sun are called robust, when they are frequently, from some other point of view, not so, being perhaps very susceptible to frost. Other dangers frequently fatal to plants are, a dry soil, a hot dry atmosphere, (quite a different thing from direct solar heat), wind, &c.

A list of plants drawn up in the serial order of their frost-endurance, would differ totally from a list drawn up in serial order of sun-endurance The question of shelter during regeneration thus demands the careful consideration, not of one only, but of all these points.

Too much stress cannot be laid on the utility of scrub and undergrowth, and especially of thorny bushes, in regeneration. In Europe they say "The thorn is the cradle of the oak," in this country it might almost be said that the thorn is the cradle and protector of everything. The right of removing thorns has been granted by Government in many places, doubtless after due consideration, *but the removal of such thorns means the removal of the last* hope of regenerating a soil trodden hard and grazed bare all around, and on which the standing crop is steadily degenerating and diminishing under the constant unpunishable "petty offences," a branch broken here, a slice of bark removed there, and the regular fires for which no responsibility is enforced on the privileged classes who cause them. To take sandal wood for instance, a timber so valuable as to be sold by the pound, the seed germinates freely, flourishes awhile, and disappears; yet the tree is robust and grows on dry and rocky soil. Why? Because the thornbush is the cradle of the sandal. Those trees that survive have in most cases had the good fortune to arise from the seed that fell among thorns, all the rest were scorched up or eaten.

The question of soil is naturally a most important one. A soil trodden by cattle into something like a sheet of rolled iron,

cannot be expected to bristle with seedlings. A dense mat of grass roots a foot deep is neither very encouraging. With these exceptions, most conditions of soil may be expected to allow the germination of seed to a fairly satisfactory extent. The existence of even a rather dense crop of herbaceous plants and shrubs is usually rather an advantage than otherwise.

It may of course be argued, by advocates of popular privileges, that we are allowed to keep closed a fourth or fifth of the forest for regeneration, which is sufficient, and we have no right to expect more in the shape of *advance growth*. But most foresters will agree that advance growth is not merely a blessing, but practically a necessity, unless we are to see the forests deteriorate under our care. Take a coppice with standards at a 30 years rotation. Seven coupes may be kept closed *nominally*, but in practice the breach of closure is too frequently, at any rate in Bombay, a "petty offence," and so far from the offender being punished, the forest guard may be reprimanded for oppression, and the Divisional Officer also for allowing it. Experience of this system has shown that there is generally a fair regeneration by stool shoots, but a lamentable absence of seedlings. If the mature crops were always complete and vigorous this would not much matter, but in fact, the crops are usually not complete, in some cases very incomplete, and consist to a certain extent of stools that are now, or will soon become, unable to throw up shoots worth the ground they occupy. There is not a single seedling on the ground before the felling, nor in most cases after. The soil, even if protection is allowed to be made real, will take a year or two to recover its permeability. By that time it may be covered with a dense mass of climbers and coarse grasses, which may as likely as not be set ablaze. Who then will venture to say that the period of closure allowed is sufficient to secure the regeneration (much less improvement) of the forests entrusted to us, if we are not to expect any advance growth. Though many of these coupes no doubt look well enough at present, for a coppice generally does look vigorous so long as it is less than ten years old, the real question is, what will a considerable proportion of these coupes look like by the time they are 25 to 30 years old.

Returning to our subject, M. Guinier seeks to establish two propositions with reference to regeneration in high mountain conifer forests. The first of these is not as completely intelligible as it might be ; *viz.*, "1st.—Contrary to appear-'ances sometimes, natural regeneration is not impossible 'anywhere, but is brought about after very variable periods and 'by very different means.

The second proposition is intelligible enough, and referring, as it does, to silver fir and spruce, is a somewhat radical variation on the classic ideas ; *viz.*; "2nd.—Generally seed is produced, and the

'young plants begin to prosper, only from the time when the 'forest has become *very open*, and the soil covered with a crop of 'small broad-leaved species, shrubs or small trees."

It is claimed that these conditions refer also to forests of other species, such as oak. Such may be the case, and undoubtedly is so, in some cases. It follows that full advantage can only be taken of the fact by a proper system of cleanings closely watched and carefully timed and executed. Whether M. Guinier is right or wrong with regard to the French forests of which he speaks, is a question which does not for the moment affect us much, as the Uniform Method is not yet adopted in India. What we have to do is to find out the cultural needs of our own species in our own districts, and on this point the letter of A. W. Lushington in our May number is a step in the right direction. Nevertheless it is necessary to note that there is in France a feeling that the "close seed felling" imported by M. M. Lorentz and Parade from Germany, does not always give the results that were expected. It will be remembered that this classic felling consists in leaving standing just so many trees that their branches may touch when agitated by a breeze, and in thoroughly cleaning the ground of all brushwood, the trees reserved being those with the highest cover. The result has been a reaction against the whole method, and a tendency to revert to ancient French systems. A curious tendency, collateral but not necessarily connected with the above, is the introduction of so-called "concentrated jardinage" under which the trees are left in a state of almost complete isolation, "in order that they may grow faster." It appears that French forest opinion is at present undergoing a phase of disorder and derangement, some of the old established ideas being discredited without as yet anything very satisfactory to take their place. We, being neither in France nor Germany, have to work out our own salvation. Their efforts will interest and benefit us, but will not dispense us from putting our own shoulders to our own wheel.

VI — *Vegetation of adult trees.*

All forest trees, says M. Guinier, are of robust temperament as soon as the young plant has reached a certain age, which may be a few weeks or may be a few years. In the climate to which they belong, they cannot only endure the sun, but indeed have a pressing need of it, and can equally well endure the other concomitant climatic conditions. But different species have very different needs in the matter of light, and behave differently, according as they get it vertically or laterally.

Light demanding species (such as pines) are those which only attain their normal shape and finest development when more or less isolated. Nevertheless these species, if they are to furnish long, straight timber free from knots, have to be kept in close canopy for a great part of their growth, being thinned out, when they have attained the necessary height, to such an extent that the lateral branches have

free room to develop. Such species afford insufficient protection to the soil, which should be kept covered by means of an undergrowth possessing dense cover.

Close canopy species (such as fir, spruce, and deodar) are those whose young plant is more or less delicate, but which are capable of forming fine trees in a state of isolation, and can also form fine trees in close canopy, provided they are not dominated. It is this class of tree which furnishes long cylindrical logs free from knots, having that straight fine grain and narrow uniform increment which in the conifers distinguish good timber from bad. In close canopy these species morover form an annual shoot as long as or longer than they would do in the open, provided only that moderate thinnings prevent their becoming overcrowded. Spruce and deodar are remarkable for the magnificent crowns they develop when isolated, but as forestry is not a decorative art, it follows that these are the very trees which have most need of the crowded state, in order to avoid the otherwise inevitable and ruinous large knots. Fortunately they can endure this crowded state as well as any.

Shade-demanding species are few and not very important.

(It will be observed that M. Guinier makes three, instead of our usual two, classes with respect to light requirements). Yew, box, holly, and a number of evergreen shrubs, are such as will pass the whole normal length of their life in comfort under a fairly dense cover. But even these species (especially the yew) will sometimes attain exceptional demensions if they are more or less isolated. It is not strictly correct to class the "close-canopy species" as "shade-demanding species," in view of the important distinction that in later life the one class will endure being dominated, while the other will not. The question is not one of infancy, but of mature life.

In "seeking the light," trees have different habits. The broad leaved species will undergo remarkable contortions in order to get the leader or a side branch into some opening inconveniently situated. Resinous species, for the most part, disdain such undignified demeanour. They will do their best to pierce the cover overhead, but if they fail, the leader ceases growing, and the tree dies (unless of course it belongs to a species that can persist indefinitely under cover). When a crooked tree is found, it is generally the result of mechanical entanglement among the branches it sought to pierce.

An important and interesting subject of study is the sequence of events following the destruction of a forest. In many cases, at high altitudes or in populous districts, the forest once destroyed is destroyed for ever. But fortunately,, in other cases the forest does but suffer a temporary eclipse. In Sind, forests are washed bodily away. But soon a "Kacha" or alluvial flat is formed. This becomes covered with a dense growth of Tamarix. Among the tamarisk appear young plants of babul or Populus, and also of

"kandi" or Prosopis. The tamarisk attains its maturity and disappears, leaving a fine babul forest in its place. This may remain indefinitely a babul forest, but it sometimes happens that the river recedes, leaving the quandam babul forest high and dry above the reach of floods, when the forest becomes one of kandi, and eventually, if things come to the worst, a desert with a few scattered bushes of kandi and caper. In the Himalaya, the people burn a bit of splendid fir forest and cultivate the land for a few crops. Thrown out of cultivation, it becomes covered with Indigofera, Spiræa, &c. This gives place to a quite European-looking broad-leaved forest of birch, horsechestnut, hornbeam, hazel, Pyrus, &c., &c., containing many fine trees, among which the seedlings of spruce and fir establish themselves and so bring things back to the starting point.

In the Punjab and elsewhere, a forest may be destroyed by fire or otherwise, or excessive fellings made, with the result that the area becomes a hopeless and dangerous sea of grass 20 feet high. The life of this may or may not be perpetuated by continually burning on the part of those interested in grazing, but there comes a time when the clumps begin to die out, and when young plants of good species establish themselves, or are inserted, with every expectation of success. These and such like problems, with those connected with light, when, how, how much, offer a vast field for enquiry. Patient, persevering observation of facts, cautious deduction of reasons, are the only safe guides.

F. G.

VI.—EXTRACTS NOTES AND QUERIES.

Forestry in the Ardennes.

BY W. R. FISHER.

Owing to the great demand of the Belgian coal-mines for wood, the owners of forests in the Ardennes can sell all their forest produce at remunerative rates and as a very large area of this region, at elevations of between 800 and 2,000 feet above sea-level, and with a stiffish loamy soil, resulting from the disintegration of quartzites and slatey rocks is unsuited for permanent agricultural cultivation, much attention has, during the last half century, been paid to the improvement of the forest growth, for which the moist climate, with an annual rainfall averaging 35 inches, is most *suitable.*

Standing, as I did yesterday, on an elevated hillside, I could see before me the dark green patches of Scotch pine and spruce woods ; the white bark of the birch standards, on extensive tracts of Communal land ; the brown rounded contours of the beech and oak woods ; the bare patches of brown heather or evergreen broom, and the pastures and fields they overlooked. The coniferous forest has been introduced during the last half century ; the beech and oak woods are the relics of the vast forest which, in the days of Julius Cæsar, extended from the Rhine to some distance beyond the river Meuse. The birch forest is the result of

a system of cultivation termed *sartage*, in which the common land of a village is every twenty years cleared of all forest growth except a number of birch standards, the produce being sold or utilized by the peasants, who burn the smaller branches, heather, broom, &c., on the ground; they then divide the area into portions amongst themselves, on each of which a crop of rye is grown, and the area is then abandoned to nature, the birch reproducing itself by stool shoots or seed. Any birch standards which are large enough to be used profitably for pit timber are felled with the rest of the crop.

The Belgian Province of Luxembourg contains 1,030,000 acres, about one-third of which area is wooded, and in 1847 126,000 acres were waste land covered with heather and broom. In order to remedy this state of things and to improve the then existing woodlands, the Government undertook to supply seed gratis, and provided five nurseries for forest plants. The utilization of the waste land was, however, so well taken up by the landowners, that by the end of 1887 only 42,000 acres of waste remained in the province, the balance having been converted into 49,000 acres of arable land pastures and 35,000 acres of woods.

Private enterprise having thus been properly directed, Government was able to relax its efforts, and by 1882 all the nurseries were sold to private people and free distribution of seed and plants was stopped.

The area in 1889 of forests in Luxembourg is given in the following table:—

PROPRIETOR.	High Forest.		Coppice with Standard.	Simple Coppice.	Land freshly sown or planted.	TOTALS.
	Beech and Oak.	Conifers, chiefly Scotch Pine.				
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
State	3,487	..	24,425	..	..	27,912
Communes ..	25,683	7,170	99,234	47,848	3,426	183,361
Hospitals	10	..	15	274	..	299
Private Owners .	35,954	37,077	45,746	42,669	12,050	173,496
Totals ..	65,134	44,247	169,420	90,791	15,476	385,068

The average annual production of an acre of forest, as calculated by a Special Government Commission appointed in 1883, is as follows, for the different classes of forest:—

High Forest	Beech and Oak ...	70	cubic feet.
	Coniferous ...	70	,, ,,
Coppice with Standards	...	56	,, ,,
Simple Coppice ...	...	35	,, ,,

Probably the production of coniferous forests was understated and may be placed at 100 cubic feet.

The price of standing wood by the cubic foot varies as follows, according to size and quality :—

Oak	...	... 9d. to 3s.
Beech	...	... 4½d. „ 10d.
Coniferous	...	... 3d. „ 4d.

(Coniferous wood hitherto only used for pit props and wood pulp.)

The production of pit timber is very profitable, and woods of Scotch pine, spruce or larch, about thirty-five years old, are worth £40 to £60 per acre. In this case the soil being worth from £4 to £10 per acre, and the cost of sowing or planting per acre being from 25s. to 40s., the initial capital is from 105s. to 240s., which, placed at 6 per cent. compound interest for thirty-five years, will amount to £29 and £66, so that it is clear that this crop yields about 5 per cent. The above figures do not include charges for supervision and land tax, which are, however, covered by the receipts from thinnings, as even thinnings in a Scotch pine wood twenty years old are saleable at about £4 net per acre.

Oak wood finds the same employment as in Britain, and large beech trees are sawn into planks, which are afterwards used for making gun-stocks, furniture, and other purposes, whilst the smaller beech trees are made into sabots (wooden shoes), the manufacture of which forms a great local village industry. Although coal is plentiful, there is a fair sale for fire-wood. The average produce from the forests of Luxembourg is placed at 56 cubic feet per acre, worth, including fire-wood, 2½d a cubic foot, and producing a total net revenue of £190,882.

Beside the sales of wood, a small revenue is obtained by leases of shooting, pasturage, sale of grass, broom, and by temporary cultivation in the forests, producing altogether about £15,000, or 9d. an acre. The rates for shooting-leases, especially in forests where there are red deer, are increasing, and may amount to 1s. 6d. an acre, and even more. The forests are not fenced and red deer roam from forest to forest ; except for their preference for larch, of which they ruin the young plantations, they do not appear to be very hurtful to the woods : hares are becoming numerous and do more damage, but fortunately rabbits are rare.

The method under which high forests, except coniferous woods, are generally managed, is to go over the area every twenty years and thin them, trusting almost entirely to nature to re-stock the area. As a result of this system of periodic thinnings, many of the forests have become insufficiently stocked, bilberry and heather forming the soil covering, a sure sign of deterioration of the soil. The coniferous forests are generally clear cut at an age between 33 and 40 years, as soon as they are large enough to serve profitably as pit-timber. The area after felling is generally

sown up for a year with rye and then re-stocked with conifers, generally by sowing the Scotch pine or planting the spruce.

As an example of a well managed private forest in this region, situated at a distance of about 60 miles from the Belgian coal-field, I propose describing what is being done in the forest of Mirwart, belonging to two brothers named von der Becke and to Dr. Schlich, the well-known author of the Manual of Forestry, who himself manages these woods. Their total area is 3,000 acres, and they are situated on undulating land on both sides of the little river la Lomme, the picturesque old historic chateau de Mirwart being about 6 miles from the town of St. Hubert. The best part of these woods is on a northern aspect facing the chateau, and consists chiefly of beech up to 130 feet in height, with some fine oak and sycamore. This wood contains 3,000 to 4,000 cubic feet per acre; in it an oak attains a diameter of 2 feet in about 100-120 years, and beech and sycamore the same diameter in 80 to 90 years

In other parts of the forest of Mirwart, oak standards over coppice prevail, with beech trees sometimes isolated and sometimes in little clusters: here almost everywhere the coppice stools appear to be too old to give healthy shoots, and the latter are overshaded by the beech standards, so that any further treatment as coppice with standards is unadvisable. A change of system is also called for, because the price of coppice is constantly falling and oak bark hardly pays for stripping, whilst beech standards are very branchy and yield much less timber than beech in high forest.

Besides the above woods, there is an area of 75 acres under simple coppice of oak, with some ash, hornbeam and alder, and 125 acres under Scotch pine poles of different ages, up to 40 years. Larch has been planted, 200,000 plants having been placed in the blanks about 40 to 50 years ago; but these plants have been nearly all destroyed by red deer. Larch disease is also common, though some of the trees, 40 years old, are very fine and healthy. *Owing to these misfortunes*, larch will in future be planted only experimentally on areas with a northerly aspect. It is interesting to note that some natural reproduction of larch has appeared under the older larch trees.

The beech woods and the irregular coppice with standards were managed up to 1892, when the present owners acquired the Mirwart estate, under the system of periodic thinnings already described, and which gave as bad results as might have been expected. High forests can only pay when the ground is kept fully stocked and sheltered by a dense crop of trees, and the soil soon deteriorates, when the cover is interrupted by excessive thinnings. The areas under coppice with standards were also suffering from the bad reproduction of the old stools and the injudicious distribution of the reserved trees. The chief problem, therefore, for Dr. Schlich, when he undertook the management of these woods, was to substitute a high forest treatment everywhere in the old coppices and to dispose of the badly grown isolated beech and oak standards in the course of 8-10 years, whilst preserving intact for

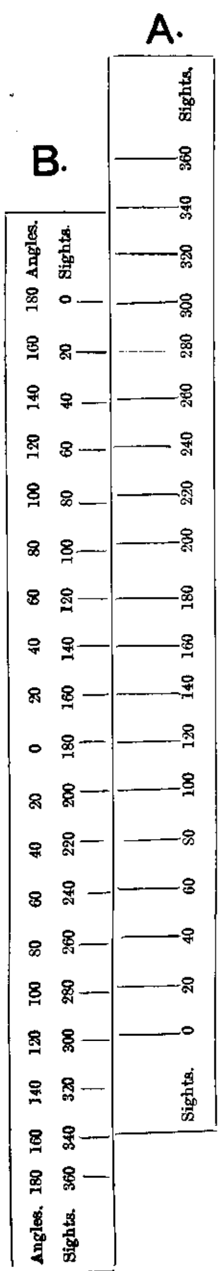
future working the fine beech woods in front of the Chateau.

With this object in view, 1,000 acres are being cleared of all defective and over mature trees and of the underwood, only promising oak standards and groups of beech poles or saplings being left intact; the area is then planted with three-years old spruce plants at distances of $3\frac{1}{2}$ to 4 feet apart, the whole work, including the cost of the plants, 6s. per 1,000, costing 25s. per acre. The timber which is being removed is sold standing at about £25 per acre, whilst the value of the future crop, when forty years old, including the standards which have been left, is estimated at £80 per acre. All the standards have been carefully pruned of dead branches and of low growing living ones less than three inches in diameter, the cost of this operation being covered by the sale of the branches pruned off. In selling the timber, it is usually divided into small lots of standing trees, which have been previously marked and are sold by public auction, the underwood being sold separately by area in small lots.

The young spruce plantations have succeeded admirably, the rate of growth of the coppice shoots having been too slow to interfere with their growth; many of those planted in 1894 are already 4 feet high, and with shoots of $1\frac{1}{2}$ feet last year. In some of the drier parts, Weymouth pine has been planted instead of spruce, and some three years' old oak plants have also been planted on a small area, and several thousand ash plants on a locality specially suited for this species. The spruce is planted in pits about 9 inches cube, the pits being dug by men at 1s. 8d. a day, whilst the planting is done by women at 1s. per diem.

As soon as the 1,000 acres of inferior forest have been dealt with, *i.e.*, after 1902, the fine beech wood referred to above will be treated and regenerated naturally. There are some parts in this wood where patches of small beech seedlings have already developed, and the older trees surrounding these patches will first be removed, and fine oak saplings five feet high planted in them, in order to get a large mixture of oak with beech. It is estimated that the regeneration of the fine beech wood will not be concluded until 1930, when the areas planted with spruce will be ready to yield heavy spruce thinnings and also a supply of timber from the broad-leaved standards, and thus the continuity of yield in the forest will be maintained.

Before terminating this paper I should like to refer to the piscicultural enterprize of Mr. von der Becke. He has prepared fifteen tanks with a total area of twenty acres, and stocked twelve of them with 40,000 small trout of the following species :—Californian rainbow trout (*Salmo irideus*), American brook trout (*S. fontinalis*), Swiss lake trout (*Truta lacusris*), American black bass, the small-mouthed variety (*Micropteris dolomeus*), as well as the indigenous trout. It is surprising to see how rapidly these trout increase in size, and I have just seen a basketful, caught with the fly, of 16 trout, weighing 8lbs., which were put into the tank in April, 1894, when they were six weeks old.



Slide Rule for Angles.

To give the Angle Comprised between two Compass Readings.

In plotting a compass survey, it is sometimes desired to use the angle contained between two bearings, rather than to lay off each from the North point. A slide rule can easily be made out of two strips of wood, card, or paper, which will save all the trouble of additions and substractions of angles. The strips may be of any length sufficient to show the half degree, say $360^\circ \times \cdot 05'' = 18$ inches. These strips are then ruled to scale, showing degrees and half degrees, the quarter being obtained by estimation. The rule A is simply divided as above. The rule B is similarly divided, but bears two rows of figures. Above the figures indicating degrees is another row showing the complementary angle. That is to say, if X is the difference between the two compass readings the angle required will be X—180° or 180°—X, according as X is itself greater or less than 180°.

Now suppose the two compass readings are 300° and 240°. Required, the angle between them. The 0 of the scale A is brought opposite to 300° on the scale B. Opposite to 240° on A is found 60° on B. Above the 60° on B is found 120°, which is the angle required. The illustration does not show the full graduation of the scales, being two small, but the principle is clear.

PAUL VESSIOT.

(*In Révue dés Eaux et Forêts.*)

Plant Pathology.

Diseases of plants induced by Cryptogamic Parasites, By Dr. Karl Freiherr von Tubeuf. English Edition, by William G. Smith B.Sc., Ph.D. Pp. xv × 598. (London : Longmans, 1897.)

When the German edition of this work appeared, early in 1894, it at once took rank as one of the most comprehensive and accurate treatises on the subject that had as yet appeared, and the English edition we now have to welcome still deserves this tribute to its merits, for the author has taken the opportunity of adding considerably to the already bulky volume.

The fungus-diseases of plants now number so many forms, that no apology is necessary for treating them separately from the very numerous other diseases of plants ; but it should be clearly borne in mind that only part of the very wide subject of the pathology of plants come under this head, as may be readily seen on comparing the new edition of Frank's "Krankheiten der Pflanzen" which has appeared in the interval, and of which the first volume is devoted to the diseases due to non-living agents, the second to those caused by parasitic plants (not fungi only,) and the third to pathological states induced by animals.

Thus comprehensive works on the whole range of this vast subject are not wanting, and the student should observe that the standpoint from which a treatise like this is written differs considerably from those assumed by writers on the general subject of pathology, or those who deal with the morphology and physiology of the fungi.

Berkeley, Frank, Sorauer, and Hartig have shown that the diseases of plants constitute a theme by itself which may be treated with reference either to the symptoms and progress of the pathological conditions, where the victim of disease furnishes the principal phenomena discussed, or to the causes or agents which induce these pathological conditions. These agents may be internal or external, and the latter comprise factors of the non-living environment, or living organisms—animals or plants in anti-biotic relations to the host, or victim.

The present large volume, of more than 600 pages with 330 illustrations, is devoted, as said, to the narrower theme, and bears witness to the astonishing progress made in the study of the parasitic fungi during the last quarter of a century.

Its subject matter is principally the fungi themselves, and in character it partakes of the nature of a flora or diagnostic list, and a treatise on symptoms and therapeutics, with bibliographical references for those who wish to launch further into this particular arm of the sea of knowledge. It is thus neither a complete treatise on the biology of fungi, nor a detailed work on pathology, but—and in this reside its peculiar characteristics—a volume compiled to meet

the wants of an increasing class of students who wish to know something of the parasitic fungi themselves and what plants they attack ; something of the mode of attack and the symptoms induced; and something of the suggestions for combating the diseases which have been supplied by experiments in the field. It is thus a typical example of a class of book evolved under the stimulus of the practical spirit of the age, and, in fairness to all be it said, of a high standard of excellence as scientific literature ; further, it will be of no use to the crammer, to the examinee, or the dilettante, but must take its place on the shelf of the serious worker, the true naturalist, and the educated cultivator of plants as an indispensable work of reference.

The book consists of two parts, of which the first contains chapters on the nature of parasites and parasitism, the reactions between host and parasite, infection, predisposition, preventive measures, and the economic importance of the diseases of plants, together with a short summary of the facts of symbiosis.

The second, and far larger part, is devoted to a systematic account of cryptogamic parasites—the fungi proper, slime-fungi bacteria and pathogenic algæ being included. The system followed is that of Brefeld, the saprophytic forms being omitted.

One fault of omission must be mentioned, if only in justice to those who have done good work in this country : the English literature is almost wholly ignored. We hesitate whether to blame the author—who only follows the too common practice of continental writers—or the editor for this. In any case the latter might have included references to Massee's and Somerville's experiments with *Plasmodiophora*, in his notes, to say nothing of other work by English botanists.

A feature in the work, which adds immensely to its value is the selection of photographic illustrations of the diseased plants themselves, showing how the victims of fungus attacks look. This is as near an approach to taking the student into the field and showing him the disease at work, as can possibly be made in at book ; *and when we reflect that this—so to term it—clinical study* is as important for plant diseases as it is in the case of human diseases, its importance is obvious. Few people are aware how much there is to be seen and learnt in the natural history of the disease of forest and field and garden plants, and Tubeuf's examples should stimulate botanists to pay more attention to the subject. It is true the reproductions of the photographs are by means of the detestable "process blocks," which disfigure most of the books of the present age ; but I suppose we must agree that the choice lies between these or none, as prices and means go.

It will be evident that the book is too large for even a brief review of more than the principal headings, but there are one or two features of importance which stand forth in salient contrast to anything met with in similar works.

These are signs of the times. One of the most striking is the far too meagre note on "selection of hardy varieties"—the word "hardy" does not accurately translate the original. From all sides we are now hearing that different varieties of vines, potatoes, wheat, &c., show different disease-resisting powers. and Tubeuf says, "An important method for the protection of plants from disease. . . . consists in the selection and cultivation of varieties and species of plants able to resist the attacks of parasitic fungi."

The very brief account of what has been done with the vine and the reference to what has been discovered about wheat, will only leave the reader hungry for more information.

Another feature of interest and importance in Von Tubeuf's book, is the chapter on "preventive and combative measures," involving the treatment of diseased plants by means of chemicals. Here, again, I notice a lack of attention to the English literature: Berkeley, and other of our countrymen, had experimented with sulphur in various forms long before most of the authorities mentioned had taken the matter up. Still, it is quite true, the introduction of Bordeaux-mixture, and its employment on the enormous scale adopted in France, Australia, America and elsewhere, have taught us much, and suggested more. It is a common mistake to suppose that the intelligent application of remedial measures to plant-diseases does not pay—there are plenty of witnesses to the contrary; but, unfortunately, school and university courses generally have allowed of so little attention to the knowledge that must be utilised in carrying out such measures, that even skilled farmers, foresters, and other cultivators of plants, have to enter upon these experiments quite unequipped for carrying them out properly.

Tubeuf's chapter of the "economic importance of plants" may be cordially—if sadly—recommended to all who are interested in the very necessary extention of technical education by the institution of the agricultural school and colleges. He quotes the losses due to the Californian vine-disease (1892) at 10,000,000 dollars; in 1891 the wheat-rust cost Prussia over 20,000,000*l*., and Australia something like 2,500,000*l*. Even allowing for large exaggerations—though reports from Sweden, India, Ceylon, the West Indies, and elsewhere suggest similarly large losses from fungus epidemics—in these estimates, it is evident that we have here to deal with annual losses of which even a saving of a very few pounds *per cent.* would be worth consideration; and the comparatively meagre experiments to hand, hold out hopes of much more considerable saving, if steps are taken in time, with a due and intelligant knowledge of the problems to be faced, and the methods of facing them.

This must suffice for our review of this excellent book, the technical details of which are well treated, of the highest importance, and abounding with interest to the naturalist and botanist as well as to the technologist and practical cultivator.

China or Indian Ink.

The Province of Wuhu, says Consul Fraser, produces the celebrated Indian ink more correctly called China ink (Encre de Chine), used by artists who paint in water-colours. From here it goes to every part of China and all over the world ; in 1895 about two tons of it were exported to foreign countries from Shanghai, valued at £564. It may be made in other parts of China, but the best comes from this province. The materials with which this beautiful black ink is made are the following :—(1) Sesamum oil, colza oil or the oil expressed from the large poisonous seeds of what Dr. Brettschneider calls the Dryandra cordata, or Elœococca verrucosa called by the Chinese Wu Tung, a tree extensively cultivated in the Yangtsze valley and also well-known in Japan ; (2) varnish ; (3) pork fat. The lampblack made by the combustion of these substances is classed according to the materials and the grade of fineness, and also according to the time taken over the process of combustion. The paste made of this lampblack has some glue added, and is beaten on wooden anvils with steel hammers. Two good hammerers can prepare in a day 80 pieces each weighing half a pound. A certain quantity of musk (of the muskdeer), or of Baroos camphor, for scenting it, and gold leaves, are added ; the latter, the quantity of which varies from 20 to 160 to to the lb. being to give a metallic lustre. The materials thus prepared are moulded in moulds of carved wood, dried (which takes about 20 days in fine weather), and adorned with Chinese characters in gilding. About 30 or 32 average-sized sticks of ink go to the lb. The price varies from 2s. or less, per lb., to so much as £7 per lb., there being over a dozen different grades. Nearly all writing is done by the natives throughout this immense Empire, in Japan, Corea, Tonquin, and Annam, with this China ink rubbed down on a stone ink-slab, and applied with a paint-brush of sable, fox, rabbit, &c., hair, set in a bamboo holder, and when not in use carefully covered with a protecting brass cap. The superior kinds of this ink appear to be used in China and not exported.

Kapok.

Kapok is the Dutch name for the seed-hairs of the white silk-cotton tree *Eriodendron anfractuosum*, which grows throughout the East Indies, the variety from Java being regarded as the best. It is, however, too short in staple, too smooth, and too soft to be spun into yarn. Its chief use is for stuffing pillows, mattresses, and sofas, where its lightness, immunity from moth, its softness and elasticity render it superior to all but the best qualities of feathers, wool, and hair. A valuable account of this interesting natural product is published in the *Indian Agriculturist* for February 1897.

Eriodendron anfractuosum is a lofty forest tree, with a large straight, trunk, covered, when young, with prickles. The branches are horizontal, and arranged in whorls. In Java, the growing trees are commonly used for telegraph posts, as the branches grow so conveniently at right angles to the trunk, that they do not interfere with the wires. The flowers are large and white, and are followed by dry, cucumber-shaped capsules, filled with black seeds embedded in silky hairs.

The seeds are sometimes eaten. They yield a bland, fatty oil, the residual cake being used as a cattle-food. In India the tree yields an almost opaque dark-red gum, which is said to be astringent, and has been used medicinally. The wood is soft, and is used in tanning. From the bark there is sometimes prepared an inferior reddish fibre, which is used locally for making ropes and paper. It possesses, however, no commercial value, and the barking of the trees would not compensate for the injury done to them, as a source of floss.

The kapok, or floss, is according to present demand, a fibre of considerable importance. It is said that its elasticity and harshness prevent it from becoming matted like the generality of flosses. It is important, as pointed out by Dr. Watt, to guard against an error "made by many writers, of viewing kapok as a generic trade name for all the silk-cottons—including that of the *simal*—the floss of *Bombax malabaricum*. When the demand for kapok first started, Indian exporters placed on the market a quantity of very dirty *simal*, having a large percentage of dust as well as seed. This was at once condemned, and was sold at a price that would not cover the transport charges. India thus fell into an inferior position, which might have been avoided if carefully cleaned fibre had been sent to Europe.

Serious complaint is made in Australia and elsewhere of the quality of the kapok shipped from India. "Even at the low price of Indian kapok (about 3d. per lb.) it is found better to pay 8½d. or more, per lb., for kapok grown in Java. The former is frequently received in such a filthy condition as to be almost unsaleable." The hydraulic or steam-press packing of kapok tends to destroy that peculiar elasticity to which it owes its value. In addition, the packing tends to express a dark-coloured oil from the seeds left attached to the fibre, and hence a noticeable difference in colour between the Indian and the beautifully white Java products.

At Java the trade has assumed a uniform practice. No unclean stuff is shipped, but the different grades of cleaning denote standards of quality ; the first, "extra cleaned," is the first picking of the crop, and is cleaned by machinery ; the second, denoted as "best cleaned picked," being all hand-picked and free from seeds, except an odd one here and there ; the third, is simply designated "cleaned." It contains a few seeds, together with the "slubs," or little knotty curly lumps, which are cast aside from

the higher grades. Packing is all done in straw mats, and the floss is never tightly pressed.

The silk-cotton tree also grows in the West Indies, but for all practical purposes it is counted of little value. Considerable difficulty was at first experienced in the importation of silk-cotton, owing to its great bulk and the heavy cost of transport, but this has been overcome by a silk-cotton press constructed by Stork and Company, at Henglo.

In the annual report of the Direction of the Botanical Department, Jamaica, 1884, the following remarks occur :—

"It now only remains for some enterprising firm to initiate the collection of silk cotton in Jamaica, and to ship it in well-packed bales for the European market. If each cotton tree yielded at the rate of about 100 lb. weight of clean floss, there might be exported from Jamaica every year about 3,000 bales of silk-cotton of the value of £9,000."

In Ceylon, kapok is collected throughout the villages of the interior. The season commences in May, and one crop is obtained each year ; the tree reaches maturity about the fifth year.

Australia receives large shipments of kapok both from India and Java but it is difficult to obtain reliable statistics concerning the trade. It is entered at the local Customs under all manner of names, such as "vegetable fibre," "vegetable wool," "silk-cotton," "tree cotton," "raw cotton," and "small cotton."

So much attention is kapok receiving in the East Indies, that the cultivation of the trees is even said to be ousting coffee in the province of Burma. Kapok has not been received in England on a very large scale ; 100 bales a month are sent from India and Ceylon (1 bale = 200 lb. Ceylon, 400 lb. Indian), and the price varies from 2½d. to 4d. per lb.—*Imperial Institute Journal.*

Non-Inflammable Wood.

An interesting demonstration.

A very practical test against fire of wood made non-inflammable by the process introduced by the Non-Inflammable Wood Syndicate, Limited, 2, Army and Navy Mansions, Victoria Street, London, S. W., was given to H.M. Office of Works on Tuesday. The demonstration, which took place on the site of the old Millbank prison at Westminster, was witnessed by the Prince of Wales and many of the leading architects and builders of London. Two buildings precisely alike in all essential respects, were erected by Messrs. John Mowlem & Co., one of which was constructed of ordinary building timber, and the other of timber made non-inflammable by the new process. The kinds of timber entering into the construction of both buildings were the same, viz., the frame

and covering of pine; the interior finish of ash, oak, birch, and mahogany. Both buildings were attacked simultaneously by flames produced by setting fire to equal quantities of dry timber thoroughly saturated with petroleum stacked against the sides of the two buildings. The result was most interesting. The untreated building was quickly enveloped in flames, and before very long completely gutted. The treated building, on the other hand, remained practically unaffected by the heat. An attempt was afterwards made to fire the treated building by piling up dry timber, thoroughly saturated with petroleum, against its inside walls and setting fire to it, but the blaze inside failed to kindle the walls of the building, which resisted every endeavour to set it alight. The process by which this wood is rendered uninflammable consists of a series of careful manipulations whereby the timber becomes uniformly impregnated throughout its entire bulk and texture with a fire-resisting compound, after the natural juices of the wood have been removed from the wood cells and vessels, which securely protects it from all danger of combustion. And this protection, too, is permanent, since the fire-proofing substance with which the cells and tubes of the wood are impregnated is not affected by any change of climate or temperature; in fact, age adds to the degree of firmness with which the fire-resisting crystals adhere in the cells of the wood. It should be stated, moreover, that the fire-treating compound is colourless, odourless, and absolutely harmless to health. It does not attract moisture; it does not discolour the wood; it does not affect materially the working of the wood; it merely adds a little to its weight. In general it may be stated that treated wood can scarcely be distinguished from non-treated wood. It is also stated that the treated wood is largely protected from dry-rot, insects, worms, &c.

The wood treated by this process, it should be added, appears to have no effect on the tools, as far as sawing, planing, &c., are concerned and it is as easily worked as ordinary wood.

The War Department of the United States is about to adopt the process for the treatment of all timber to be used in ammunition stores, forts, barracks, &c. The Japanese Government has also adopted it for the treatment of all timber entering into the construction of the two cruisers now being built for that country in United States ship-yards. In addition to this, several of the newest and largest office buildings in New York City have no wood used in their construction except that fire-proofed by this process. Many leading architects of the United States are likewise specifying wood treated by this process.

Already plants for treating wood are in operation in New York City, Newport News, and San Francisco, and others are being erected in Philadelphia, Chicago, and other cities. A plant capable of treating large quantities of timber is now being erected in London.—*Timber Trades Journal.*

Monograph of Indian Bamboos.

The Government of India has recently issued a circular inviting attention to the publication (as Volume VII of the Annals of the Royal Botanic Garden, Calcutta) of a monograph of Indian bamboos, by Mr. J. S. Gamble, M. A., of the Imperial Forest Service. The book has received the highest commendation from Sir Joseph Hooper, and contains an account, as well as an illustration, of every known species of bamboo found in the Indian Empire. The price of the book is we understand Rs. 14. Copies are procurable from the Superintendent of the Royal Botanic Garden.

A Forest School for Burma.

We are glad to hear that there is some probability of effect being given to the proposal to establish a Vernacular Forest School in Burma for training recruits for the executive staff of the Department, the necessity of which has long been admitted. The new school will probably have its head-quarters at Tharrawaddy in the Pegu circle.

Schlich's Manual of Forestry.

We would invite the attention of our readers to the reduction in the price of Dr Schlich's Manual of Forestry, as advertised on the cover of this number.

THE

INDIAN FORESTER.

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The Export Works in the Bamsu Forest, Jaunsar Division, School Circle, N.-W. P.

The Bamsu Deodar Forest which is leased from the Rajah of Tehri Garhwal, is situated on the right bank of the Tons River, and comprises an area of 2,323 acres.

The stock consists mainly of Deodar with a mixture of Rai (*Picea Morinda*), Morinda (*Abies Smithiana var Pindrow*) and Kharsu oak *Quercus semecarpifolia* in the upper portions and of Kail (*Pinus excelsa*) and Ban oak (*Q. incana*) in the lower portions.

A Working plan for this and the neighbouring deodar forests leased from the Rajah of Tehri, from 1885 to 1905, was drawn up by Mr. Hearle, Deputy Conservator of Forests, and came into force from 1st April, 1885.

The main provision of the working plan is that not more than 2,000 *green* deodar trees are to be felled annually, from the blocks set aside for the corresponding period, together with all available *dry* deodar trees from the areas in which the green trees are felled.

In accordance with the provision of this plan, work should have commenced in Bamsu during 1892-93, but owing to the disaster to the Deota slide and other causes, the work in the Deota forest was delayed and fellings in Bamsu did not commence till 1893-94.

The total number of 1st class trees *i. e*, those over 6′ in girth contained in the Bamsu forest, according to the valuation survey made, amounts to 12,725, besides which there are 11,029 *2nd* class trees *i. e.*, those from 3′ to 6′ in girth.

Under the provisions of the working plan 6,000 1st class green deodar trees were authorized to be felled, but the actual number cut has only amounted to 5,799 green and 3,020 dry trees, the felling and sawing work having been completed in December, 1896.

The total outturn from the above trees has been as follows :—

			c. ft.
Broad gauge Sleepers		$10\frac{1}{4}' \times 10\frac{1}{4}'' \times 5\frac{3}{4}''$	... 31,465
Metre gauge Sleepers		$6\frac{1}{4}' \times 8\frac{1}{4}'' \times 4\frac{3}{4}''$	3,98,109
Karis	$10' \times 5'' \times 4''$	$6' \times 5'' \times 4''$	... 1,592
			4,31,166

The average distance of the Bamsu forest from the Tons river is about 7 miles, the line of export which is along the gorge, being interrupted in the middle by a precipice and waterfall of about 500 feet perpendicular height.

It had at first been intended to construct two sections of water slide with a wire rope shoot down the precipice, but the fate of the Thadior slide in August 1889, and the great success of the Deota and Thadiar sledge roads decided the adoption of the latter method of transport.

The upper and lower sections of the Bamsu khud presented no great difficulty in the selection of a good line for the sledge road, but the lower portion of the upper section called the Bamsu gorge, where the stream dashes through a precipitous defile for a distance of 2,200 feet, presented almost unsurmountable difficulties. A good line was, however, eventually found and laid out, principally by Pundit Rama Dutt, Forest Ranger, under whose direct supervision the works have been carried out.

The total estimate for the works including buildings, wire rope shoot, &c., amounted to Rs. 18,837 against Rs. 22,750 proposed by the framer of the working plan, but owing to the exercise of economy and careful supervision, the actual cost amounted Rs. 14,604 only.

Subsequently during 1895-96 a short length of water slide aggregating 3,450 feet was added, above the upper section, at an additional cost of Rs. 1,188.

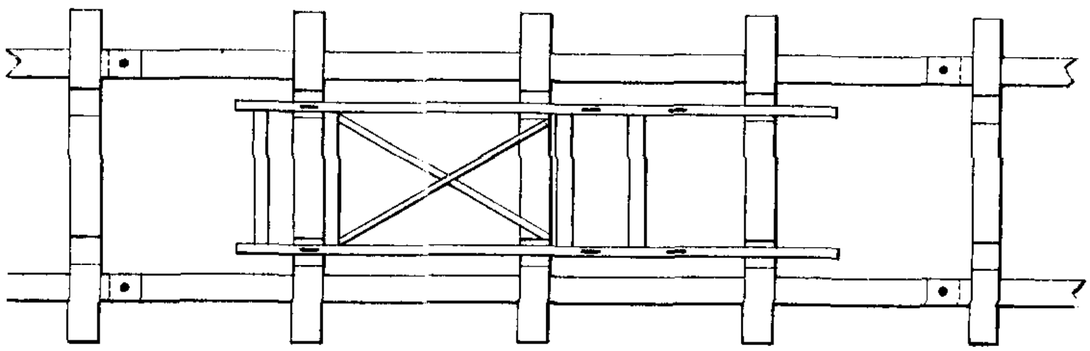
The construction of the sledge road was commenced in November 1892, and completed by the middle of July 1894, and the following is a general description of the work, and the order in which it was undertaken.

I. Cutting and sawing the timber required for the bridges and roadway, the work having been started as early as possible in order to allow the timber to season before being used.

II. Cutting and embankment work which was very heavy. This part of the undertaking it was important to complete as early as possible, so that during the rains of 1893, the embankments might settle themselves and the unavoidable landslips which happen on all new roads in the hills might take place without damage to the roadway when laid.

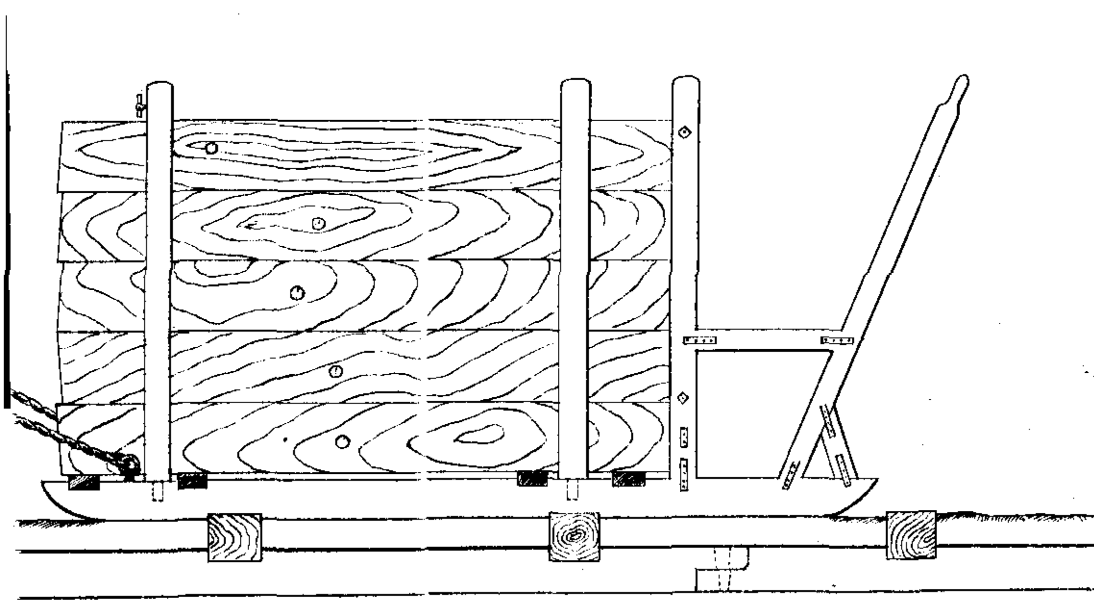
III. Blasting operations, which were very heavy, and which it was important to do by degrees, thus avoiding unnecessary work which often takes place if done in a hurry.

SYSTEM OF ROADWAY AND SLEDGE USED ON THE BAMSU SLEDGE ROAD



PLAN

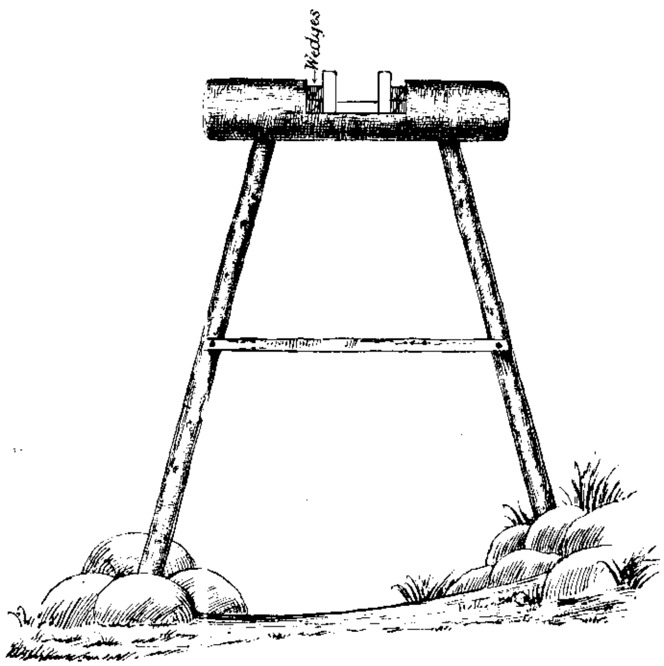
Scale 3 Feet=1 Inch.



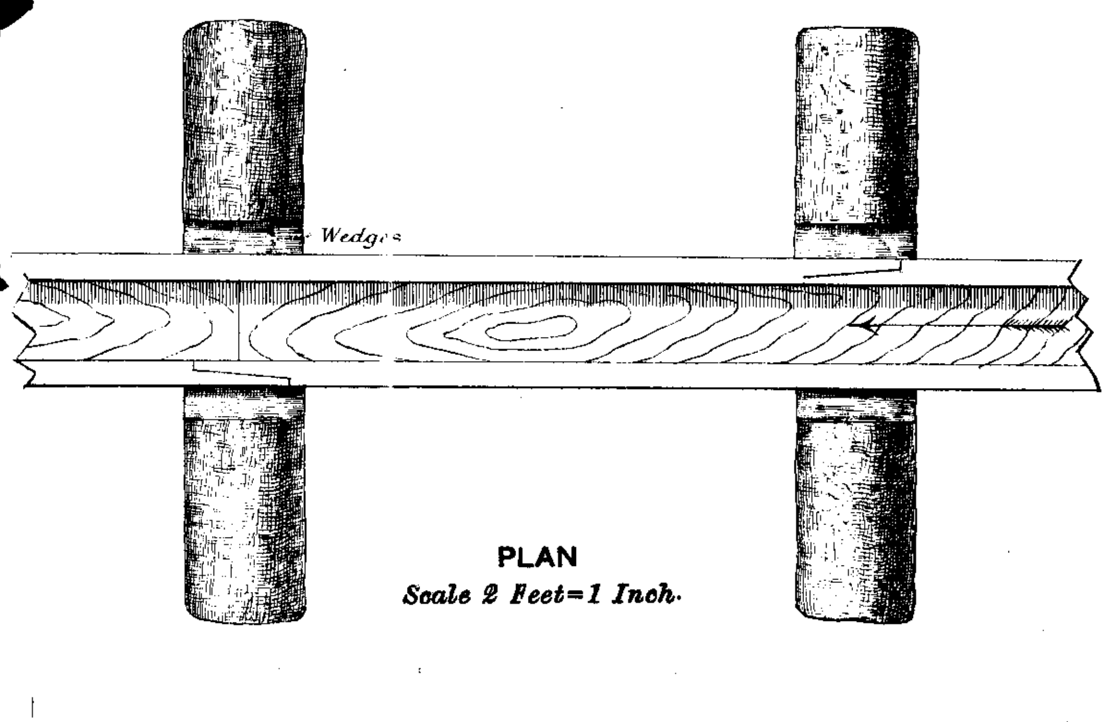
ELEVATION

Scale 2 Feet=1 Inch.

BAMSU WET SLIDE



SECTION
Scale 4 Feet=1 Inch.



PLAN
Scale 2 Feet=1 Inch.

IV. Construction of the piers of the main bridges, which were all done by skilled masons, and on daily labor under proper supervision.

V. Laying down of about 3¾ miles of timber roadway, the work having been commenced from the top, so that the sledge road was used for the transport of a good deal of the timber required for the middle and lower sections, and thus a considerable saving was effected on the cost of carriage by means of coolies.

VI. Laying the beams and completion of 57 timber bridges on both sections of the sledge road.

VII. The erection of the wire rope shoot in three spans, having an aggregate length of 1825 ft. and a total fall of 881 ft. down the precipitous ground below the Bamsu gorge.

The Bamsu sledge road has been constructed in two sections, called the upper and the lower, as it could not be made continuous on account of the presence of a stupendous cliff and a waterfall in the middle, already referred to.

As stated above, the interval between the upper and lower sections consists of a series of precipices having a total fall of 881 ft. down which a three-span wire rope shoot, with an accompanying carrying stair and rough track, have been successfully constructed.

The general nature of the Bamsu sledge road is similar to the Deota and Thadiar sledge roads of the Deota range constructed in 1884 and 1889, detailed descriptions of which are contained in printed reports dated September 1885, and April 1890.

For those who have not seen these reports the following brief description with the accompanying diagrams may be of interest.

The Bamsu sledge road commences at a convenient point in compartment I of the Dhikuri Block, the depôt where the road begins, having been selected on account of its being the central point to which most of the timber from the upper part of the Forest had to be carried.

From this point the sledge road follows the Bamsu stream where the ground was found to be fairly easy, to the entrance of the Bamsu gorge already described.

The total length of the upper section which terminates on the edge of the cliff where the wire rope shoot has been constructed, is 9,819 feet and includes 2,200 feet constructed in the rocky Bamsu gorge.

In this part much blasting had to be done and the stream has been crossed seven times in order to avoid heavy rock cutting.

The total length of the 16 bridges on the gorge portion of the upper section aggregates 1,600 feet.

The lower section of the sledge road commences at the foot of the cliff at the place where the wire rope shoot terminates, and runs down through fairly easy ground to the bank of the Tons at the Mora depôt where the sleepers are stacked and launched.

The work on this section was much easier than on the upper part of the sledge road, but still there was some heavy blasting

work to be done near bridge No. 6 and the stream had to be crossed six times on this section.

The length of this lower section of the sledge road is 9,551 ft. and the total length of both sections, including the branches at the depôts, aggregates 19,370 feet or $3\frac{3}{4}$ miles, as compared with $1\frac{1}{8}$ miles of sledge road first constructed at Deöta, and $1\frac{1}{2}$ miles afterward constructed at Thadiar in the same Range.

The total number of blasts exploded was 3,456, and the amount of powder used amounted to 754 lbs. It is satisfactory to be able to state that no accidents of any importance occurred during the progress of the blasting work.

The drainage of the sledge road has been carefully attended to, the water being let off below the roadway by a system of rough troughs.

There are in all 57 main bridges and viaducts on the Bamsu sledge road the aggregate length of which is 3,894 feet.

The principal and most difficult bridges to construct were Nos. 2, 16, 21, and 23 all on the upper section.

Bridge No. 2 has been constructed in an especially awkward part of the Bamsu gorge, the large beams supporting the roadway being fixed into the rock on each side, a task of no little difficulty.

In all dangerous places strong railings have been erected on both sides of the bridges and have been found most effective in preventing accidents.

The wooden roadway over which the sledges run, consists of longitudinal beams generally 12′ or 10′ feet long by 5″ by 5″ placed 2′. 9″ apart and connected by means of transverse beams 5′ to $5\frac{1}{2}$′ long by 5″ by 4″ spaced from $2\frac{1}{2}$′ to 3′ apart according to the gradient of the road.

In the transverse karis or beams are cut nicks, from 6″ to 10″ wide and $\frac{1}{2}$″ deep in which the sledges run. When these nicks become too deeply worn, a piece is cut out of sleeper or kari, and the place is filled by a loose piece, carrying a new nick at the correct elevation. These loose pieces, instead of being rectangular, have one side coned, and are inserted from the rear, so that the friction of the sledges, always downward, keeps them tight up to their seat.

The longitudinal pieces and cross beams are all joined together by means of strong morú oak (*Quercus dilatata*) pegs and the whole roadway is firmly embedded in good ballast.

The gradient of the sledge road varies from 4° to $11\frac{1}{2}$° or from 1 in 14 to 1 in $5\frac{1}{2}$, the average being about 6 degrees.

On steep gradients in order to restrain the velocity of the sledges, the cross pieces are placed 3 feet apart and rough grained timber such as chir (*Pinus longifolia*) is used, whereas on low gradients the cross bars are placed 2 feet apart and fine grained hard timber such as tun, shisham, &c., is used, deodar being

employed on intermediate gradients. A great economy in the use of oil and soap has thus been effected by the perfecting of these simple but important arrangements.

The sledges employed on the Bamsu sledge road are somewhat larger than those used on the Deota and Thadiar sledge roads, but are built on the same plan, as represented in the accompanying diagram.

The large sledges used for sledging B. G. sleepers are 11 feet long and 2′ 4″ wide, whereas those used for sledging M. G. sleepers are the same breadth but $9\frac{1}{4}'$ long only.

The scantling of the runners of the sledges is $11' \times 4\frac{3}{4}'' \times 1\frac{3}{4}''$, and $9\frac{1}{2}' \times 4\frac{3}{4}'' \times 1\frac{3}{4}''$ and the best timber for the runners is found to be the two local oaks, called Bani (*Quercus annulata*) and Morú (*Quercus dilatata*) but shisham is also used for the upper bars and handles of the sledges.

The sledges are constructed to carry 15 B. G. or 25 M. G., the dead weight being over a ton.

The sledges are worked by two men, it being the principal duty of the man in front to guide the sledge into the grooves, also to pull or restrain the sledge according to the gradient; whilst the man behind moderates the pace of the sledge by means of a rope attached to two iron rings, or pushes it forward as necessity arises.

At first, the sledge men, after reaching the lower depôts and depositing their freight, dragged the sledges up again along the road; but this plan was soon given up for the easier one of carrying the sledges upon their shoulders.

Many suggestions for brakes or drags have been made, but no practical arrangement, except the free use of sand on the steep gradients, has yet been arrived at.

The effect of very wet weather on the sledging is that there is considerable difficulty in starting the sledges even on steep gradients; but when once started they tend to bolt; so that at such times sledging is either altogether prohibited, or permitted only on the condition that three men, two behind and one before, take charge of each sledge.

The working of the Bamsu sledge road has been found to be the most satisfactory of the three sledge roads constructed in the Deota Range, and this is mainly due to the extra care bestowed on the laying out, and careful perfecting of the roadway, also to the kind of timber used, as already explained, and to the use of beds of sand on the steep gradients, which act in a most effective manner in checking the velocity of the sledges when passing over them.

Only two serious accidents have occurred during the working of the sledge road, which resulted in two men being killed, but the accidents were mainly due to the men's inexperience and carelessness and not to any fault in the construction of the road.

The following is a statement of the financial result of the Bamsu sledge road from the commencement of its working in April 1894 up to the end of March 1897.

The total number of M. G. and B. G. sleepers and of other pieces of timber transported during that period amounts to 3,57,104. *The actual cost of the sledge road, amounted to* Rs. 14,604.

The actual cost of working down the above timber by means of the sledge road stands as follows :—

		Rs.
Actual cost of sledging the above timber amounts to	...	12,316
Add cost of making and repairing sledges	...	1,491
Ditto repairs to sledge road ...	...	1,145
Miscellaneous items, oil, soap, &c., ...	...	837
Total ...	*Rs.*	*15,789*

The total expenditure incurred on the sledge road including original cost, &c. is therefore Rs. 30,393. Now, had the above timber been transported over the same distance *viz.* $3\frac{3}{4}$ miles on coolies' backs, the actual cost would have amounted at least to Rs. 97,867. Therefore the net financial result of the Bamsu sledge road up to the end of March 1897 is a gain of Rs. 97,867—30,393 or Rs. 67,474.

As a lakh of sleepers have yet to be transported by its aid, the ultimate saving effected by the use of the Bamsu sledge road instead of coolie carriage, will probably amount to about one lakh of rupees.

The Bamsu wire rope shoot which connects the upper and lower sections of the sledge road consists of three spans having an aggregate length of 1,825 feet.

The total fall is 881 feet and the spans and gradients are as follows :—

No. of Spans.	*Gradients.*	*Vertical height.*
I 634 feet	26 degrees	274 feet
II 759 "	$31\frac{1}{2}$ "	402 "
III 432 "	27 "	205 "
Total 1,825 feet.		881 feet.

The wires used consists of Bullivant's patent steel $\frac{3}{4}$ inch diameter wire ropes, which combine strength and durability with lightness, and are far superior to the ordinary galvanized iron wire ropes, though more expensive.

On the first and third spans a single wire is the means adopted, but on the middle section, which is the steepest, a double endless wire running round two wheels or drums, with their axles approximately vertical, has been employed, and works satisfactorily.

On the upper and lower spans the sleepers are attached to the wire ropes by means of morú oak saddles which reduce the

wear and tear of the wire caused by the friction to a minimum and are found to work fairly well. At first it was intended to use soft iron hooks or saddles as in the case of Dandot Colliery wire rope shoot in the Punjab, but the oak saddles are found to be preferable.

At the lower ends of the spans the ropes are given the proper tension by means of rough winches to which the ropes are firmly attached.

The middle section, as already stated, consists of a double or endless rope passing round two wheels, this arrangement being adopted on account of the gradient having been found too steep for the single rope system.

To the rope are firmly attached two cars, the loaded car, carrying four M. G. sleepers hauling up the empty car, which is then loaded and sent down from the other side of the wheel.

The working of the single wire rope sections is found to be fairly satisfactory, but occasionally the sleepers fall off through the sudden breaking of the oak saddles or some other mishap, also if the tension of the wire happens to be too great they occasionally get smashed against the timber barriers erected at the lower end of the spans.

The working of the middle section is found to be the best and though somewhat slower, fewer breakages take place.

The total carrying capacity of the Bamsu wire rope shoot 250 sleepers per day only, and as the wire ropes began to show signs of wear and tear after about 20,000 sleepers had been slid, the work was discontinued, especially since it was found that the cost of carriage by means of coolies over the same sections amounted to about the same cost, *viz* 8 pies per sleeper. The breakages and damage in the case of the wire rope shoot also amounted to about 6 per cent, whereas in the case of coolie carriage it is nearly nil. Under the circumstances therefore, the shoot was abandoned, but its use has had the effect of reducing the cost of coolie carriage from one anna to 7 or 8 pies per sleeper and has therefore resulted in a considerable saving.

It has been already mentioned that after the completion of the sledge road wire rope shoot, it was found desirable and practicable to construct a length of wet slide or "flume" to join the upper end of the sledge road in the Bamsu khud.

The total length of the wet slide, which was completed in July 18?5, is 3,450 feet and the original cost amounted to Rs. 1,188.

It is constructed on the same principal as the old Thadiar slide which was used for about 10 years for the export of timber from the Deota Forest, but instead of high and expensive retaining walls, which often shook down, a system of rough trestles has been employed for supporting the slide, and these have been found much cheaper and more satisfactory.

The slide consists of a rough trough formed of three planks

measuring from 6′ to 10″ long by 11″ wide and 3″ thick, the inside measurement of the slide being 11″ by 8½″.

The beams are roughly jointed but no nails are used, and the accompanying diagrams represent the nature of the wet slide.

The slide is firmly wedged into block sleepers or small logs 6 long by 15″ diameter placed at intervals of 5′ to 6′ apart, these being supported on rough trestles or embedded in rubble masonry, according to the nature of the ground.

The maximum gradient of the slide is about 20 degrees and the minimum 5 degrees.

The timber used for the beams of the slide is kail (*Pinus excelsa*) and for the trestles and block sleepers any kind of common wood such as oak, chestnut, birch &c.

A plentiful supply of water is required to work the slide and this is let in at intervals of about 200 yards according to the gradient and leaky condition of the slide.

A rough method of caulking is effected by throwing in dead leaves which fill up the joints.

The M. G. sleepers are launched on their broad sides, and B. G. sleepers on their narrow sides, the pace at which they travel naturally depends on the gradient and amount of water available, &c.

As jams sometimes take place, a number of chaukidars are stationed along the slide to help the sleepers along.

These jams are due to the following causes :—

1st.—Stones getting into the slide.

2nd.—One sleeper travelling on its narrow surface getting alongside of another on its broad side.

3rd.—Insufficiency of water due to drought, leakage, &c.

At the Bamsu forest sufficient water remains in the khud to work the slide for about nine months in the year, but at the old slide in the Thadiar khud of the Deota forest the working season only lasted from 15th June to 15th October, and again for a month during March after the melting of the snow.

From July 1895 up to March 1897, the following timber has been slid at Bamsu.

M. G. sleepers	=	172,000
B. G. ditto	=	9,800
Karis	=	6,000

The financial result may be represented as follows :—

Cost of carrying the above timber on men's backs over the length occupied by the slide at various rates Rs. 6,080.

Deduct

(*a*) Original cost of slide	... Rs.	1,188	
(*b*) Cost of working down the above timber by means of the wet slide ...	,,	1,270	
(*c*) Repairs, improvements, &c. ..	,,	222	
Total ...	Rs.	2,680	2,680

Net gain in favor of the wet slide ... ... Rs. 3,400.

As there are about 50,000 sleepers still to slide, the net financial result will probably amount to about Rs. 4,500 net profit.

Mention has been made above of the old Thadiar slide; for those who are unacquainted with its former existence and untimely fate, the following brief description may be of interest.

The old slide was situated in the Thadiar khud which drains the Deota forest, the total length being 12,000 feet and original cost Rs. 26,000.

It was constructed in 1878 on much the same plan as the Bamsu slide above described, except that a large expenditure was incurred on retaining walls, rock cuttings and tall masonry piers which very often came to grief from the action of floods, vibration of the slide, &c.

The Thadiar khud having a large catchment area of steep hill sides running up to 10,000 feet, is subject to sudden floods, landslips, &c., so that the slide was continually getting damaged by floods, falling rocks, boulders, trees, &c., and was a source of constant anxiety to the officer in charge, especially during the rains. On the other hand the Bamsu slide being situated high up near the source of the Bamsu khud, is not nearly so liable to damage from floods as the Thadiar wet slide was, and therefore works much more satisfactorily, also being situated in the cooler climate, the timber is not liable to shrink and warp half so much at the Thadiar slide which became unfit for working unless there was a large supply of water available to counterbalance the leakage, &c.

However, the Thadiar wet slide may be said to have worked well for about 10 years, the financial result up to the date of its total destruction on the 8th of August, 1889, being estimated at Rs. 38,000.

As the readers of the *Indian Forester* of that period may have forgotten a description of that catastrophe given in one of the numbers of that time, the following is a brief account of what actually happened.

About 6 p. m. on the 8th of August, the year above stated, a furious storm burst on the Deota ridge, 6 inches rain having been registered in a few hours.

About 10 p. m. a tremendous flow of water, mud and *débris* of all kinds, reached the head of the slide, the water, from the marks left on the banks, having been about 40 feet deep.

This flood swept down the valley in a series of rushes caused by the temporary damming up of the khud, at narrow places, and in the course of a couple of hours it completely wrecked and carried into the Tons river nearly the whole of the timber slide, notwithstanding the fact that it was in some places situated 50 feet above the stream. The catastrophe was unfortunately accompanied by the death of 12 choukidars who were asleep in a cave near the

head of the slide, 20 feet above the stream. Their bodies were never recovered, having been apparently ground to paste in the mud and boulders.

The transporting power of the torrent was enormous, large boulders weighing from 20 to 100 tons having been carried along for hundreds of yards, by means of the mud, which being afterwards washed away, these boulders, may now be found deposited high and dry along the bed of the Thadiar khud. About 36,000 sleepers were also washed into the Tons River from the Thadiar Depôt. Of these about 10,000 were never seen again, and the total loss caused by the flood amounted to about Rs. 40,000, together with the 12 lives referred to.

As regards the comparative merits of sledge roads, wet slides, and wire rope shoots, the experience gained in the Jaunsar Division of the School Circle tends to demonstrate as follows :—

That sledge roads are by far the most reliable means of transport, because they are not so liable to be damaged by floods and landslips as wet slides, and can besides be worked all the year round. The carrying capacity is practically only limited by the number of sledges and men employed, whereas the working of wet slides entirely depends on the amount of water available at different seasons, on the leakage, &c.

Sledge roads are also a most popular means of transport with the hill men, and quarrels sometimes take place amongst the coolies as to who are to be allowed to use the sledges.

Regarding the use of wire rope shoots, the experience gained in the Jaunsar Division, is too limited to enable a decided opinion to be given as to their general suitablity in the forests of the Himalayas but as far as the experiment tried at Bamsu goes, this aerial structure is unpopular, decidedly difficult to work, causes breakage and damage to a good many of the sleepers, and in this particular case was no saving in the cost of transport over ordinary coolie carriage, except that its construction had effect in causing the coolies to lower their carrying rates over that particular section of the line of export.

E. Mc'A. M.

VI.-EXTRACTS, NOTES AND QUERIES.

Proposed Improvements in British Forestry.

By W. R. FISHER.

The climate of the British Isles is admirably adapted for the growth of trees for which a *steady supply of moisture in the* ground is the most important requisite. Nowhere in these islands is there an average annual rainfall short of 20 inches, that in the westerly parts of Ireland and great Britain *sometimes exceeding* 60 inches, and it is everywhere fairly well distributed throughout the year, occasional droughts prejudicial to tree growth being limited to the *Eastern and South Eastern counties* of England between March and July. The most recent drought we experienced was in 1893, when only 2 inches of rain fell at Coopers Hill, Surrey, during the four months March-June, whilst the average maximum temperature during each of those months was 8° Fah. above the monthly average. Even then an area of 20 acres planted out on the Bagshot sands with Scotch pine in February was a complete success, owing to the heavy February rainfall of 3 inches.

The fact is that our woodlands suffer more from an excess of *moisture in the soil, than from the* soil becoming too dry, which is so often the case on the European continent. This condition of swampiness in our woodlands is generally due to the fact that they are insufficiently *stocked with trees, the natural drainers of the* soil, and this fact is most clearly illustrated by the present condition of the Delamere Crown Forest in Cheshire. This forest of 5,000 acres of freehold lands has produced *oak from time immemorial*, but has been ruthlessly thinned out by the Woods & Forests Department and is now declared unsuited, owing to its swampiness, for its growth, and is being *planted with Scotch pine. It* was visited last year by the English Arboricultural Society, and in a note on its condition, printed in the proceedings of the Society it was cited as an example of "*how not to carry out forestry*."

British winters are mild when compared with those of the continent, and are somewhat severe only in the Eastern counties of Great Britain, and the high northern moorlands. It is true that spring frosts are treacherous and may extend into June but provided that care is taken to shelter the more delicate species they offer no serious impediment to the growth of our indigenous *trees, nor even of exotics*, which like the larch, Weymouth and Austrian pines, Douglas and Silver firs, have proved to be useful constituents of our woodlands.

Strong westerly gales *from the Atlantic ocean* are the *greatest* natural obstacles against which British forests have to contend, and the deplorable ravages these gales occasionally effect were exhibited

on a large scale in the Scotch Highlands, in 1893, when about 2,000,000 trees were blown down in the counties of Forfar and Perth. That it is however within the resources of art to protect forests from storms, is admitted by the Scotch foresters, who visited the Hartz mountains in 1895 and those who may wish to study this subject fully should visit the Erzgebirge in Saxony, where they will see that even the shallow rooted spruce may be rendered almost wind-firm by suitable precautions. British experience has proved that the Corsican pine, Norway maple, sycamore, and some other species will resist the full force of the west wind and that a merely narrow belt of wind-firm trees is sufficient to protect, a wood behind it from damage by wind.

As regards soil, a fair depth, which in the moist climate of Britain need not exceed four feet, and sufficient porosity are the most important conditions and forest trees will thrive on soils, which are too sandy or too stiff, too shallow or too strong, for profitable agriculture. Even in the case of fenland and bogs, which latter have certainly once been forest land, as the presence in them of bog timber, sometimes in large quantities, testifies, suitable conditions for the growth of trees may be secured after working out the peat and draining, the question of the possibility of economic forestry in such tracts being generally only one of expense. All forest soil may be kept sufficiently rich in nutritive mineral and in nitrogenous matter provided the valuable humus supplied by their dead leaves and needles is allowed to accumulate and sufficient cover afforded by a dense leaf canopy, so that the growth of weeds is prevented and moisture retained near the surface of the ground. It is a matter for regret that these conditions are not always secured in British woodlands, there being too great a tendency to over-thin the trees, and in some of the beech woods, on the Chiltern hills, which from time immemorial, have supplied material for the important chair making industry, the dead beech leaves are removed for farm litter, and the soil, often a very shallow layer of loam above the flints and chalk, is consequently seriously deteriorating. It being then admitted that our climate and soil are fully adequate for successful tree growth, the next question arises as to the areas available, and I have attempted to give some idea of these in the annexed maps, where the relative areas occupied in each county by woodlands and wastelands are shown by differently marked squares. The following table gives these areas for great Britain and Ireland, taken from the agricultural returns issued respectively in 1894 and 1893.

	England acres.	Wales acres	Scotland acres	Ireland acres.	Total acres.
Field Crops and pasture	24,881,000	2,857,000	4,892,000	15,162,000	477,92,000
Mountain and heath-land used for grazing	1,986,000	1,055,000	9,409,000	3,888,000	16,338,000
Woods, plantations and nurseries ...	1,625,000	175,000	907,000	307,000	3,014,000
Surplus lands including road and inland water	4,052,000	687,000	4,45,000	1,349,000	10,333,000
Total Rs. ...	32,544,000	4,774,000	19,453,000	20,716,000	77,477,000

In Vol. 2 of the Manual of Forestry, 2nd edition, Dr Schlich assumes that of the surplus lands, 2,000,000 acres in Ireland, and 2,000,000 acres in Great Britain, are available for planting and that a further area of 2,000,000 acres in the larger island may be found in the mountain and heath land at present used for grazing, making altogether 6,000,000 acres capable of producing the 9,000,000 loads of timber we at present import annually. This of course requires proof, but there can be no doubt that our actual 3,000,000 acres of woodland are at present only partially stocked and that by better management they can be made to produce a much larger quantity of timber than at present, and of much better quality, so that this paper will make no further reference to the important question of the afforestation of our wastelands, but will simply deal with the possibilities of improvement in the management our actual woodland area.

That an enormous amount of planting is done annually in Britain will be at once recognized by any one who has seen the vast forest nurseries of Messrs. Dickson at Chester, where from an area of 450 acres, millions of young plants are distributed annually, or the large nurseries at Carlisle, Leith, Perth, and other places. Much of the energy expended in plantations is however wasted owing to bad choice of species for certain localities.

The chief classes of forest met with in Britain are either coniferous high forest, sometimes but not nearly often enough, mixed with beech, or with spanish chestnut in the north of England, beech selection forest as in the Chiltern hills, and coppice with standards. Scotch pine and larch are the chief components of the coniferous forest and they are generally managed under the clear cutting system, the mature crop being felled and removed and the area then planted with a young crop. In the beech selection woods on the Chiltern hills, where only natural regeneration by seed prevails, owners have occasionally forgotten that beech trees

will not produce fertile seed when less than 70 or 80 years old, and after having cut away all their mature trees, are surprised that natural regeneration has stopped. The coppice with standards consists of an underwood of hornbeam, hazel, ash, sweet chestnut, alder, and other species, with standards chiefly of oak and ash.

Besides the above chief classes of British forest, osier beds and willow pollards and standards are grown along river banks, and pure coppice of oak for tanning bark, and of sweet chestnut for hop poles and alder for gunpowder and clogs are occasionally grown, whilst the cultivation of hedgerow trees, chiefly elms and oak, prevails to a larger extent than in any other European country. Much has been written about the proper method to grow trees in all these systems, but example is better than precept and model forests of each class are required in as many places as possible in the country, so as to serve as training grounds for future foresters.

In order to meet this want of a training ground in Scotland-Mr. Munro Ferguson, M. P., President of the Royal Scottish Arboricultural Society, proposed to apply for a parliamentary grant to purchase an area of waste land and plant it up gradually, so as to form a normal high forest with trees of all ages corresponding to a rotation of say 100 years. Dr. Schlich, however, pointed out that it would take at least one if not two generations before the proposed model forest was of any use for instruction in forestry, and suggested that the Commissioners of Woods and Forests should engage an expert to draw up working plans (schemes) for a number (if not all) of the forests under their control and then see that the provisions of these working plans are intelligently carried out. In this way their own subordinates would be trained in the course of time and the work going on in these woods would afford the means of instructing new hands to be employed in the Crown Forests and private estates.

It is very gratifying to know that the Woods and Forests Department has adopted this plan. Mr. H. C. Hill a Conservator of Forests to the Government of India who has acted for sometime as head of the Indian forest service, and is now at home on furlough, is engaged in preparing Working Plans for the High Meadows wood and the forest of Dean, and if this excellent policy is continued, working plans will eventually be made for all the Crown forests and a foundation laid for scientific and economic forestry in Britain. Unfortunately there are not, I believe, any Crown forests in Scotland or Ireland and the only apparent way of providing model forests in these countries is for certain private land owners to manage their woods on similar principles to those now being introduced into the Crown forests of England.

The next step required from the Woods and Forests Department, without which, these plans for improving the management of their woods will be of no avail, is for them to train a superior

staff for the management of the Crown Forests, by attracting men of good general education into their service, who have received a professional forestry education at Coopers Hill. Two appointments as Assistant Conservators of Forests on salaries from £200 to 400 per annum, should be established in each of the Dean, Windsor, and New Forests under the present Deputy Surveyor. The emoluments of 3 Deputy Surveyors, including houses and land attached, are each worth about £900 a year, and on the occurrence of vacancies in these appointments, for which the appropriate title of Conservator of Forests should be substituted for the anomalous one of Deputy Surveyor, these posts should no longer be given as a reward for political services, but to the best men from among the Assistant Conservators. Besides the large areas of forest comprised in the Windsor, New, and Dean Forests, *there are several outlying Crown forests, such as the Delamere* Forest (5,000 acres) Salcey woods (1,266 acres) woods in the Isle of Man, &c. Men of the grade of Assistant Conservators should be placed in charge of the more important of these woods, thus rendering a uniform system of control practicable and saving the present agency charges, and also of any extensive plantations which may be started in the 300,000 acres of Crown land, or elsewhere.

Another official of similar rank to the Conservators of Forests, acting under the orders of the Commissioners, should be appointed at the Woods and Forests office to control the execution of working plans for the Crown Forests and to form new plans and revise old ones from time to time. Once it is recognized that the Woods and Forests Department has the disposal of the services of a number of trained men, no colonial forest appointments need in future be offered to foreigners, as has been already the case at the Cape, Natal, and Cyprus, but to one of the Crown Assistant Conservators of Forests. Inattention to forestry at home has been followed by indifference in the Colonies, although the permanent maintenance of the indigenous forests is a question of vital importance to most of our dependencies, but the fact that Britian is setting her house in order in this respect will probably induce colonials to follow suit and imitate the splendid and successful policy of India in this respect. It is clear that a subordinate grade of woodmen will always be required as at present in the Crown Forests; a graded service of this order should be established and, when once the Crown Forests are brought into proper order, private landowners will be inclined to apply to the Woods and Forests Department for trained woodmen for their own woodlands.

As regards education in forestry, Dr. Schlich has stated that little can be done until we have a relay of competent men trained in systematically managed forests, and capable of lecturing, and that the less said the better about lectures in forestry merely prepared from books. The Forestry Branch at the

Royal Indian Engineering College, Coopers Hill, has the Indian Forest Service to indent on for a succession of practical men as forest lecturers, and this College can train men for superior service in forestry in the colonies, as well as India, and also instructors in forestry for *Colonial Forest Schools*, as soon as the colonies perceive the necessity for them. But in order that landowners and land agents may possess sufficient knowledge of forestry to direct the management of the private woodlands in Britain, classes in forestry must be established at all our universities, as at present at Edinburgh and Durham. It is very gratifying to hear that Professor Warrington at Oxford has, by the liberality of Miss Ormerod and others, been provided with funds to start the teaching of forestry in connection with agriculture, and that a course of lectures in rural economy by Professor Somerville has been given at Cambridge. At Edinburgh there have hitherto been divided counsels and the professor of Botany has started a course of forestry instruction in opposition to that given by Colonel Bailey, one of the best of our foresters. It is to be hoped that these divided counsels will be abandoned in favour of consolidating forestry instruction on a thoroughly practical basis. The reception Dr. Schlich met with at Edinburgh last spring. when he gave an address on forestry to the members of the Royal Scottish Arboricultural Society, and again at the Imperial *Institute*, when he read a most valuable and instructive paper, on the timber resources of the British Empire, shows that the time has come when a great step forward must be made in British forestry, and the recent patriotic action of the Commisioners of Woods and Forests in preparing the Crown Forests as training grounds for the future foresters of the Empire, show that the present Government have clearly recognized their obligation in this respect.

While, however, every British Forester must desire that his profession should become thoroughly indigenous, and be well *illustrated at home by well managed* examples of varied woodlands, we should never forget the debt we owe to French and German foresters who by their courteous reception of English Forest students for the last 30 years in their magnificent forests, have prepared the way for the present revival of Forestry in Britain.—*Land Magazine.*

Sir Dietrich Brandis' Pamphlet.

There can be little doubt that the father of Indian, if not of Madras, Forestry was Dr. (now Sir Dietrich) Brandis. If we in this Presidency had produced a Cleghorn and a Beddome before the advent in Madras of the distinguished German who

was for twenty years Inspector-General of Forests to the Government of India, the effect of their labours had been but local. Throughout the greater part of India systematic forestry owed its very commencement to Dr. Brandis, and the Indian Forest Department was unquestionably created by him. He possessed the supreme advantage of having secured the confidence of the Government of India. All Governments in India have to decide a vast variety of questions of which they are crassly ignorant, and being ignorant, they are suspicious and afraid of being imposed on. The Government of India's ignorance is the most extensive, because its range of power is greatest, and it is of course proportionately nervous of being taken in. The first thing, therefore, which the head of a Department must do, if he would advance, is to make the Government of India believe *in him. Once this is accomplished, it will follow* him like a little child. Dr. Brandis succeeded in the operation. Beginning with Lord Lawrence, who was by no means a warm supporter of the new Department, he gradually built up a reputation as a safe and strong man. In Province after Province the re-organisation of the Forest Department was carried out on the lines he laid down. In 1881 he visited Madras, and the result is to be seen in the Madras Forest Act of 1892, under which all subsequent forest operations have been conducted. In 1884 Dr. Brandis retired, being rewarded by the bestowal of a K.C.I.E., and he has now published a *brochure* in which he traces the course of Indian Forestry and endeavours to suggest the lines of its future development. It is not unnatural that the veteran, who has so long controlled the destinies of the Department, should hope still to direct its course, still more natural that he should wish to recall his achievements in the past; but it must be added that distance from India frequently lends an enchantment incompatible with rugged realities, and that the removal of responsibility has an astonishingly enlivening effect on the once staid official pen.

Sir *Dietrich Brandis'* main recommendation in the pamphlet under notice is the extended employment of Natives in responsible offices of the Forest Department. Like a well trained man, he first supports his proposal by a quotation from Sir Thomas Munro, whose Minutes have been a perfect gold mine of quotations to official writers ever since Sir Alexander Arbuthnot rendered them accessible. Then he points out that Native Forest Officers possess the great advantage that they cannot be accused of "want of sympathy" with, or "absence of knowledge of the people." Lastly, and with most force, he urges that unless systematic Forestry is accepted by the educated classes of India as a sound principle, it must remain an exotic and would immediately expire were the foreign influence supporting it removed. Forestry must be naturalised in India if it is not to be looked

upon as an alien invention, and naturalisation can be best effected by raising Natives of the country to responsible positions in the Forest Department. The Dehra Dun School must be strengthened and extended. Similar schools must be established in other parts of the country, notably in Burma. As Japan sends young men to Germany to study in the forest schools of that country, so India should send the pick of Dehra Dun to complete their forest education on the Continent of Europe. "It will be a great point gained when the first Native 'is appointed to the post of Conservator of Forests." Such are Sir D. Brandis' proposals. And it must be admitted that he does not altogether omit to notice the difficulties of his scheme, namely, the failure of Native Forest Officers in the past and the extreme scarcity of suitable Native candidates. He believes, however, that if "an honourable and paying career" is assured, desirable candidates will not be wanting, andin the matter of successful native working he appeals to the evidence of Native States such as Mysore. But we may well doubt whether the matter is so simple as it looks. The educated classes in India are unfortunately specially ill-suited for forest employ. The Brahmin, and his non-Brahmin imitator, has neither taste nor capacity for jungle work. His physique is generally unfavourable and his indifference to natural history deprives the Department of one of its chief attractions. Mr. Dansey, Conservator in the North-West Provinces, is quoted by Sir D. Brandis as writing :—"The 'most unprofitable of all subordinate Forest officers is the town-bred 'schoolboy who has no previous experience of jungle life, jungle tribes 'and jungle conditions generally." Hence if the ordinary Cutcherry recruit is enlisted in the Forest Department, he will be willing enough to visit Germany at the public expense and to enter the higher ranks of the Department, but he will be as far as ever from being a practical Forester. Already the wholesome rule with which the Dehra Dun School started has proved unworkable, *viz.* that no student should be received who had not proved his fitness for the Forests by several years' work as a volunteer or forest guard. The problem is not to be met, as Sir D. Brandis suggests, merely by offering better pay and prospects, which would only attract the usual place-hunting class. A practical test in active forest work must be imposed. A stringent physical examination must be insisted on, and candidates must be looked for among the more robust and active, rather than among the most intelligent, classes. Even so, the measure of success will not be high, and forest administration will probably long remain largely in the hands of the European and European descended races.

The remainder of Sir D. Brandis's proposals are directed to the legitimate extension of forestry in India. The steady growth of population, he points out, necessitates the extension of forests; otherwise the increasing demand for forest produce must in the end outrun the supply. He especially insists on the

paramount importance of maintaining the minor forests and pasture lands. The large timber forests furnish the backbone of the departmental revenue, but it is to the smaller areas that the people have to look for their local supplies of forest produce, as well as for pasturage in the dry season. Sir D. Brandis gives an interesting account of the results which followed the handing over of the waste and jungle in Ajmere and Merwara to the inhabitants. In a few years the hills were cleared of trees, the reserves of pasture were gone and the tanks were destroyed by the torrents which poured unchecked down the hill-sides. The effects on the population were most serious. A similar story has to be told of the Hoshiarpur District of the Punjab, where 7,000 acres of fertile land have been laid waste by torrents coming from the denuded hills. The importance of pasturage in seasons when the rains fail is rightly insisted on, and Sir D. Brandis makes a protest, albeit in diplomatic language, against the Government of India's recent policy of establishing settlements in the heart of the more remote forests and of relinquishing minor forests for cultivation. He advocates, on the contrary, the establishment of village forests, such as exist in Germany. But when he goes on to suggest that the selection of such tracts should as far as possible be intrusted to Native agency and apparently left to Municipalities and local bodies, it is clear how the leaven of retirement has entered into his soul. "The blessings of progress," he tells us, "will be valued more by the people, if they are not 'all dispensed by the hand of the foreigner." The blessings of forest progress are seldom appreciated at all by the people, but we may well pity them when these blessings are bestowed and controlled by the incorruptible agencies referred to.—*Madras Mail.*

Concentric Rings in the Mangrove.

The Madras Report for 1895-96 has the following "It was 'found in the Kistna District that the annual growth in diameter 'of the mangrove (*Avicennia*) amounts to nearly an inch and from '1 to 2 feet in height. It is considered that the spurious rings 'are monthly and are probably due to the different conditions of 'nutrition caused by the spring and neap tides."

We would ask other officers in whose districts mangrove forests lie to verify this statement and enquire and examine whether any of the mangroves put on a ring showing the completion of a periodical growth once a month, whether all species exposed to the influence of tides do so, or only some and whether they do so every month, and send the result of their investigations for publication in *the Indian Forester.*

Insect ravages among Teak and Anogeissus latifolia.

Teak in the whole Southern portion of this District has been entirely defoliated by a small caterpillar. In 1892 the same thing happened in the Ahiri Forests in Chanda. I tried then to get the mature insect from the caterpillar, but unfortunately all the insects I had collected were attacked by Ichneumon flies and came to nothing. The parenchyma of the leaf is only eaten, the veins and midrib being left intact. Hardly a single tree has escaped, and the whole forest where teak predominates has a sombre brown appearance.

Dhaura (*Anogeissus latifolia*) has also suffered badly. In this case, however, the entire leaf is eaten and Dhaura is now beginning to send out a few bunches of new leaves. The damages have extended over a large area and in some localities not a single tree has escaped. In 1892 Dhaura suffered by the same insect. This was also to be observed in the Ahiri reserve. I wonder if this is the case in other Districts as well. Unfortunately I have to travel about fast and can take very little luggage, or I would try and collect and identify the above insects. On the 27th I traversed 32 miles, principally though Teak forest and I cannot recollect seeing a single tree that had entirely escaped. Many did not show a single green leaf. I cannot say how the rest of the District has fared as I have not seen it since the commencement of the rains.

R. C. THOMPSON.

CAMP DAMOH, C. P.
29th July, 1897.

Oil Buchanania latifolia Seeds.

Buchanania latifolia is locally known as *char* or *achar* in the Central Provinces. The fruits, which ripen in May are much eaten by the natives, the cotyledons inside the seed, locally known as "*chirouji*", being the parts used, which are eaten either raw or made into a sweetmeat with sugar. Apart from this use, the cotyledons give an excellent colourless, tasteless, and inodorous oil. Up to the present time the Gonds and Korkoos have not extracted the oil to any great extent, though they knew of its existence and though I made an extensive enquiry, I have been unable to discover any local use of the oil.

The oil is extracted by the Gonds and Korkoos in an ingenious way, which was only adopted by me when all other means failed. The method consists of :—first pounding up the

cotyledons into a coarse paste in an "*ukhree*"* care being taken not to have it pounded too fine, as the finer the paste is, the less the quantity of oil secured—the paste is then exposed to steam for a quarter of an hour by putting it in an earthen pot with a hole in the bottom, placed over a narrow necked earthen pot containing water kept at boiling point. Thirdly, the hot paste is neatly tied up into a bundle in a piece of blanket and is then ready for pressing. The paste is twice put through the above process, after which it ceases to produce oil.

The press consists of two logs of equal dimensions, each with one side roughly squared and with holes bored in one of the extremities, through which a stout rope is passed forming a kind of hinge. In addition, the lower log is also provided with a disk, at about a foot from the hinged end, surrounded by a groove with an outlet for the oil to escape, the disk slopes on all sides towards the groove which is about an inch in breadth and depth. The bundle containing the hot paste is put on the disk and the upper log placed on top of it. The free ends of both logs are then drawn together by means of another stout rope and as the pressure increases the oil comes out.

From actual experiments conducted by myself, I found that about 2 lbs. of the cotyledons produce about ½ lb. of oil

S. N. C.

5th August, 1897.

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* A native contrivance for pounding any kind of grain.

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Sir Richard Strachey and Indian Forestry.

The readers of the "Forester" doubtless have noticed the name of Richard Strachey in the list of Diamond Jubilee Honours. To him is entirely due the present organization of the Forest Department, and this fact has never been sufficiently recognized. When, in February 1861, the Government of India ordered the Pegu Forests to be thrown open to private enterprize, these orders were issued in the Foreign Department, which at that time controlled the entire administration of that newly-annexed province. In November 1861, the measures taken by the Government of India were objected to by Her Majesty's Secretary of State. But before his despatch had reached Calcutta, the subject had once more been considered by the Government of India, and doubts were entertained, whether it had been right to deviate from the policy laid down in regard to the Pegu Forests by Lord Dalhousie. Accordingly it was determined, for the future, to deal with questions of Forest Administration throughout the Empire, in one Department of the Government of India. As the then Secretary in the Public Works Department, Colonel (afterwards Sir Henry) Yule, and his successor then Colonel Richard Strachey, took a special interest in forest conservancy, that Department was chosen.

Thus, when in the autumn of 1862, the writer of these lines was called away from Rangoon to assist the Government of India in the organization of Forest business in the other provinces, Richard Strachey was his Chief. In Pegu it had been my privilege to serve under Colonel (afterwards Sir Arthur) Phayre, and now it was my singularly good fortune to commence my work in a more extended sphere under one of the ablest Indian Statesmen of our time. At that time, Lord Elgin was Governor-General of India. He died in November 1863 and Sir John (afterwards Lord) Lawrence landed at Calcutta in January 1864, Lawrence had saved the British Indian Empire in 1857, mainly through

the resources of the Punjab and the fidelity of its people. By strong, just and considerate Government he had firmly attached them to British rule, and this result he had attained by insisting upon personal Government by his district officers. He held that the chief civil officer must be supreme in his district and that there must be no departmental interference of any sort. Before going out as Governor-General he had seen the despatches sent home regarding forest administration and he did not approve of the plan of establishing a new Department, that would have charge of the waste lands and forests, and that might in many cases interfere with the supreme authority of the chief civil officer in his district. It was no secret that Lawrance had determined to stamp out this new-fangled scheme. I felt my position untenable, and begged Strachey to let me go back to Burma, where I wished to continue the work which I had commenced. He asked me to have patience, to put up with the unsatisfactory state of things, and to remain attached to the Government of India. Gradually, Richard Strachey obtained sufficient influence over the Governor-General, to enable us to do useful work in India. Sir John Lawrence soon learnt to value Colonel Strachey's powerful help in extending irrigation works on a large scale and, later on, in devising a system of Railways to be built by the State. It was due to Richard Strachey's steadily growing influence and to the patient perseverance of his successor as Secretary to the Government of India, that in 1868 Sir John Lawrence sanctioned a definite organization of the Department in all provinces under the Government of India. Had it not been for Richard Strachey, Forestry would have come to nothing under Lawrence. What I have here stated, in no way detracts from the high position Lord Lawrence justly holds in the history of India. The creation of a separate Forest Department at that time was regarded as a most doubtful measure by the majority of Civil Officers. Even at the present moment, many distinguished Indian Officers view the present progressive and Departmental system of Government as a source of real danger to British rule in India. The system which after much opposition has been arrived at of making the District Forest Officer the Collector or Deputy Commissioner's Assistant and which effectually guards against all political risk, could not have been introduced in those early days, because at that time it was necessary to give the Conservator power to take the initiative in forest matters and to carry out his plans through the agency of his Assistants, acting of course always under the orders of the Local Government.

Richard Strachey's eminent services in India have long been universally recognized, and outsiders have often wondered that he had always remained plain General Strachey. His friends knew that it was not in his nature to care greatly for the decorations, by which public services usually are recognized, and he had been successful repeatedly, in warding off the attempt to confer such

titles and decoration upon him. This time however Lord Salisbury did not ask his leave, and thus we have now the great satisfaction of honouring him as Grand Commander of the Star of India. In spite of his 80 years, Richard Strachey still is hard at work in connection with Railways. He is chairman of the East India and of the Assam-Bengal Railway Companies, and his interest in Indian Forestry is undiminished. The above brief sketch of what Strachey has done to place forestry in India upon a safe footing is intended as an introduction to some important remarks of his on the aims and objects which foresters in India should keep is view. These remarks he communicated to me in a letter of 16th inst. and they are as follows :—

"If I may add a word of criticism on the position of the Forest Department at the present time, so far as my information on the subject goes, it would be that it is still only in the stage of preserving what exists and laying a foundation for what may be. It is still a blot on its administration, that it is with the greatest difficulty, that timber sleepers can be got for our railways, even where they pass through forests, as in Assam. Why should I have to send to Norway for pine poles to be used in making a railway between Benares and Gya ?"

"The attitude of Government, I am aware, is opposed to efforts to make the Forest Department commercially active and the fear of interfering with private enterprize stands in the way of much that could be done towards developing industries in India, the absence of which is one of the main causes of the relative poverty of the country and the inability of the people to resist the pressure of times of scarcity. So long as the people is exclusively agricultural or nearly so, and the numbers are double what are required for the proper cultivation of the soil and the production of food, what else can be expected but a total incapacity to accumulate wealth ? The difficulty in the way of getting out of these conditions is, of course, enormous, and cannot be overcome otherwise than with extreme slowness. But the object should surely be never lost sight of, and what is possible should be done to open the way to its realization, if it is to be postponed even for a century."

"*Laissez faire* is not the remedy for the evils that oppress the vast majority of mankind."

So far Sir Richard Strachey. In these lines he briefly indicates the great task which the British nation has undertaken in the Government of India, a task which can only be accomplished by the patient, but carefully planned, work of generations. The resources of the different provinces of that huge Empire must be developed in such a manner, as to generate and feed industries, that will increase the well-being of the agricultural population and will enable them to resist the pressure of scarcity when their harvests are diminished or destroyed by drought. Such industries as shall promote the well-being of the agricultural population, obviously must be fed chiefly by the produce of the soil. The

great aim, therefore, to which the efforts of public officers in India ought to be incessantly directed, is to increase the growth of useful products, that will give profitable employment to the people.

Where there are forests, or where forests can be raised, the greatest production of timber, bamboos and other useful forest produce on the area available ought to be the aim. Well may Strachey complain, that to this day timber for railway construction must be imported from Norway and that, even where railways pass through forests, timber sleepers can often be got with the greatest difficulty. True, one difficulty consists in this, that among the vast variety of trees in the forests of India, a few only produce timber, that will resist the climate and that will last sufficiently to be useful as railway sleepers ; further, that these kinds, which yield durable wood, are mostly scarce and that their timber can be more profitably disposed of for other purposes. Another difficulty is, that vast areas are without forests or without forest at the disposal of Government. The forests through which the Assam-Bengal Railway runs, produce no Teak, Pyinkado or Sal timber and the Nahor (*Mesna ferrea*) one of the few really durable woods, which grow there probably fetches higher prices for other purposes. Hitherto, I understand, Pyinkado sleepers have been imported for the line and the question whether *Mesna ferrea* may be made available for that purpose, is being seriously considered. There may however be timbers in the vast forests in the vicinity of that line, which, though not as durable as Nahor or Pyinkado, yet may furnish sleepers for the first construction of it. The rapid completion of the Jabulpur and Nagpore branches of the Great India Peninsular Railway about 1866 was made possible by employing sleepers of *Terminalia tomentosa* and other woods, which, though not as durable as Teak or Sal, yet are sufficiently so, to justify their use at the commencement. In those days Sir Richard Temple was Chief Commissioner, and Colonel Pearson was Conservator of Forests in the Central Provinces. The forests nearest to the line Benares-Gya which are at the disposal of Government, are the Palamau, Gorakhpur and Oudh forests. In these there ought now to be sufficient second growth of Sal, to furnish thinnings of Sal poles. One would think that by this time a sufficiently steady demand for Telegraph posts ought to have sprung up to make poles of Sal an article of trade. Nevertheless it is quite possible, that in many cases with the low rates of outward freight, it may still be possible to deliver impregnated poles of Spruce from Europe at prices lower than those at which durable Indian timber, such as Sal, Teak, Deodar are ordinarily sold in the Indian market.

When, after leaving Burma in the autumn of 1862, I commenced work in Northern India, difficulties frequently arose, in the course of direct dealings between the Public Works Department, Railway Companies or contractors, and those officers who at that time worked the Government forests. Sudden demands

were made for large quantities of seasoned timber to be delivered at a few months' notice, rejections of the timber delivered were frequent and often arbitrary and the dealings with the subordinates sent to take charge of the timber were not always satisfactory. For many cases it was found better to employ middle men in this business. Theoretically, the best plan would always be, to sell all timber standing in the forest, or, where rivers are available for floating it to the market, to sell the timber ready for launching. The work of forest officers would then be confined to the forests. It has frequently been urged, and with much appearance of justice, that in many cases forest officers in India have a great deal of deal of work to do, which is scarcely fit work for a Government Department. On a vast scale they discharge the functions of a private trader, they have to watch the state of the market, to enter into competition with other traders and find customers for their stocks of timber. Many attempts have consequently been made in different provinces to sell the timber standing in the forests and thus to set forest officers free for their more legitimate work in the Forests and in many forest districts these attempts have been most successful. This however cannot everywhere be accomplished. But wherever forest officers have to engage in timber operations on a large scale, an excellent plan is to establish timber depôts at suitable places and to hold periodical auction sales regularly at stated times. Under such an arrangement Contractors, Railway Companies, and the trade generally, gradually learn that at certain dates timber is available at these depôts, the price is regulated by the demand, and under such an arrangement forest officers have not to assume the functions of private traders. I certainly, never did a better thing than when I obtained, a few days after landing at Rangoon in January 1856, from the then Commissioner, Major Phayre, a piece of river frontage 1¼ miles long. There all the timber brought from the forests was collected and sold by public auction at monthly sales. After 1861 when, in obedience to the orders of Government, a large portion of the forests were thrown open to private enterprize under the permit system, the quantity of timber disposed of at these sales diminished, but in course of time the permit system came to an end, and to the present day the greater part of the Teak timber produced in the Pegu forests is sold by periodical sales at the Rangoon timber depôt. Similar depôts have at different times been established on the rivers which take their rise in the Himalaya for the sale of Deodar and other timber brought down on Government account, and in my opinion this system might, whenever possible, be encouraged. The system to be pursued in the disposal of timber and Bamboos grown in Government forests must however always be arranged in accordance with the circumstances of the case, it must not be regulated by rigid principles or in obedience to pre-conceived notions.

When regular forest management was commenced in India, a few kinds of timber only were marketable, chiefly those, which like Teak, Sal and Deodar were known to resist the action of decay and insects in a tropical or sub-tropical climate. Clearly, however, it is one of the most important duties of Indian Foresters to seek employment for those kinds also, which formerly were not regarded as marketable, and which were generally classed as inferior kinds. The importation of foreign timber into India, mostly of spruce impregnated with creosote, and of timber from Australia, has at times been considerable, and it certainly ought to be the aim of foresters in India, as far as timber is concerned, to make the country independent of foreign supplies.

A great deal has been accomplished in this direction. As soon as I had secured an annual surplus revenue by the sale of the old Teak timber from the Pegu forests, I brought down regularly to the Rangoon timber depôt, large quantities of other woods, carefully selected logs, which were sold by auction at the monthly timber sales. Financially this was a loss, but a few kinds were brought to notice in in this manner. The first real start however was made with Pyinkado by Mr. Ribbentrop, when Conservator of Forests in Burma between 1875 and 1877. The difficulty was, to procure a saw mill fit to cut up this extremely hard wood. This difficulty overcome, Pyinkado was used largely for the Railways in Burma and in other provinces; sleepers of this wood have even been exported to Africa, and I understand that 10 to 12 local saw mills are now at work in Burma for its conversion. In 1895-96 Government is reported to have derived a revenue of three lakhs from the Pyinkado timber trade in Burma. Another instance is the export trade of Padauk timber from the Andamans, which has gradually become of considerable importance and in the School Forests of the Himalaya I am told that trees of *Pinus excelsa* and *longifolia* now sell at good rates standing in the forest, timbers which 15 years ago were unsaleable.

What has not yet been accomplished is, to increase the durability of other kinds by impregnating them. The efforts that will doubtless ere long be made in this direction, will I hope eventually lead to the establishment of factories for impregnating Himalayan Pines and other woods. As I explained in the paper on the utilization of the less valuable trees, which was printed in the Indian Forester of February 1894, I have ever since 1875, as long as I was in India, done my utmost to bring the establishment of impregnation factories in Northern India. It is a most remarkable fact that hitherto no effective action has been taken in this direction. I am glad however to notice, that the rise in the price of Deodar timber in the Punjab has lately again directed attention to this subject.

Nor has any effective action been taken to employ the wood of the inferior kinds in order to encourage the manufacture of iron with charcoal or to obtain acetic acid and other useful products by

carbonizing it in closed kilns, On these subjects I have so often written at length lately * that I will not weary the patience of my reader by repeating what he may have read already. Most satisfactory results have, I understand, been attained in the School forests of Jaunsar by the disposal of pitch and resin, the produce of *Pinus longifolia.*

Another industry that might be stimulated through the action of foresters in India to a greater extent than has hitherto been done, is the tanning of hides. Tanning materials and raw hides are important articles of export. There is no reason why an extensive tanning industry should not be developed in India. I remember with pleasure a ludicrous sight that used to be common in many villages in Rajputana and elsewhere. Long rows of goat skins hung up stuffed with the leaves of *Anogeissus,* and along these rows a number of little boys busy pouring water into the open throats of these stuffed goats, the skins of which were thus being prepared to furnish the finest possible leather. Tanning materials are abundantly produced by the vegetable kingdom, new tans are constantly being brought to notice in different countries, and many such may still be discovered in India. I have learnt with great satisfaction, that it is contemplated to establish a central research station for forest products at Dehra Dun in connection with the Forest School, and that the Officer in charge will have the advice and assistance of the Agricultural Chemist to the Governmant of India. In the present instance however I desire specially to draw attention to a substance which has long been used by tanners and which is an article of trade in Northern India, the bark of *Acacia arabica.*

I understand that in consequence of the offer made by a large European firm at Cawnpore to take annually 250,000 maunds of Babul bark at 8 annas per maund, an enquiry has lately been set on foot, by Mr. Ribbentrop, the Inspector-General of Forests, whether it would be advisable to establish plantations upon a large scale to supply the bark, and at the same time to increase the supply of fuel in the forestless country of the North-Western Provinces. I also understand that the Conservator of forests and the Divisional Officers of the Central Forest Circle have pronounced against the scheme. and that it has consequently been abandoned.

It was estimated, that the scheme would require the taking up of 84,000 acres. which under a 12 years' rotation were estimated to yield, at the rate of 3 maunds of bark and 60 cubic ft. of barked and stacked fuel per acre per annum, an annual outturn of 252,000 maunds of bark and 50,40,000 cubic ft. of firewood. It was also estimated that the area required could be purchased at about 14 rupees an acre and that if the purchase money and the

* Utilization of the less valuable trees Indian Forester 1897 page page 57.

† Vœlcker, on the improvement of Indian Agriculture London 1893 page 758.

outlay on formation and maintenance were capitalised at 4 per cent, the amount would show a deficit, but that if the calculation were made at 3 per cent, the net revenue obtained from the 84,000 acres proposed to be operated upon, would amount to Rs. 44,000.

I can quite understand the disinclination of Forest Officers in the North-Western Provinces to embark in an undertaking upon so large a scale, the financial success of which is by no means assured. Doubts were expressed, whether the produce in firewood of the proposed plantations could be disposed of at a profit and it was urged, that the creation of extensive forests for the production of Babul bark and firewood in the centre of these provinces would close the door to all prospects of a trade in tanning materials from the existing forests, while it would at the same time affect injuriously the growing export of fuel.

Evidently it is the fear of diminishing the net revenue of forest administration, that makes forest officers unwilling to embark in such undertakings. Nor is this fear unreasonable, for as matters stand at present, even those public men who are in positions of influence in England as well as in India, and at the same time are well disposed towards regular forest management, as a rule judge the value of forest administration only by the net annual revenue it produces. A diminished surplus is regarded as proof of bad management. It is to be hoped, that in course of time broader views will prevail, and that the work done by foresters in India will be judged more by their success in increasing the quantity of useful products obtained from the soil, in augmenting the productiveness that is the capital value of the estates entrusted to their charge, and thereby contributing to develop the resources of the country.

If at the present time, financial considerations prevent large operations in this direction there can be no possible objection to taking in hand smaller areas by way of experiment, and it seems most important to urge the necessity of such experiments, which must however be undertaken on a sufficient scale, to furnish practically useful results. On pages 58 to 60 of his excellent report on *Indian Agriculture*, Dr. Voelcker gives an account of the experiments made in different districts of Northern India for the purpose of reclaiming Usar lands. The result in all cases has been, that if cattle are kept off and are not allowed to nibble away and to tread down every blade of grass, as it appears, the worst Usar will rapidly clothe itself with grass. Further, trees can be raised on Usar land, this has been proved for *Butea frondosa* in the Kapurthala State and for *Acacia arabica* at Aligarh. It is true that when in the latter experiment Babul had attained a height of 20 feet, it seemed to reach a subsoil of Kankar and die. But in order to produce firewood and Babul bark for tanning, a short solation of 12 years is contemplated, and the trees need not attain more than 20 feet in height. Usar lands are very extensive in the North-Western Provinces and in the eastern portions of the

Punjab. At Amramaau Mir Muhammad Husain, the Assistant Director of Agriculture, North-Western Provinces and Oudh, in 1882 purchased on behalf of Government 52 acres of Usar land for experiment at one rupee per acre. When Dr. Voelcker wrote,† one half of the farm had been reclaimed and was let at an annual rent of eight Rupees per acre. In this case no trees were planted, but the reclaimed land gave excellent field crops.

These Usar experiments have been objected to, because as a whole they have not been a financial success. Obviously this is no reason why they should not be continued with another object in view *viz*, that of growing Babul on a short rotation for the production of fuel and bark. The larger scheme of taking in hand 84,000 acres was based upon an excellent Memorandum by Sir Edward Buck of 29th December, 1889 and a note by Mr. H. C. Hill, Officiating Inspector-General of Forests of 1st January 1890. These two papers have, I understand, been made public, they should be reprinted in the "Indian Forester," so as to give foresters in Northern India an opportunity of fully considering the important questions involved in the proposals made by these two distinguished officers. Sir Edward Buck justly urges, that the only possibility of materially improving the agricultural character of land in the North-Western Provinces, and especially of those tracts which are subjected to the exhausting process of canal irrigation, is by providing the people with the means of substituting other fuel for cowdung, which will then be available for manure, and by adding to the amount of leaf and vegetable manure. This lies at the botton of all attempts to improve the condition of the people in the over populated districts of the country. Dr. Voelcker justly says: "could the produce be increased even by one or two bushels per acre, the difficulty of population would be met; but without more manure the soil cannot do it, and the export both of crops and of manures (bones) is removing instead of increasing its fertility. The one way in which alone this question can be solved, is by supplying more wood and thus setting free the manure for use on the land. For this purpose fuel and fodder-reserves must be established." Sir Edward Buck further explains that the Ganges canal runs through many of the large Usar plains which form a very large percentage of the Jumna-Ganges Doab. Successful plantations, he adds, have been established on the worst Usar lands in the immediate vicinity of the main canal, where the roots of the trees get down to the sweeter water percolating from the canal bed.

The essence of the plan proposed by Sir Edward Buck and Mr. Hill was to take up blocks of inferior land along the Ganges Canal and to plant them up, and in this manner it was estimated that upwards of 250 square miles or 160,000 acres might be obtained. The work of establishing and maintaining this plantation would be undertaken by the canal officers, with the

assistance of a Conservator of Forests in professional matters and a sufficient number of Forest Rangers who had received their professional education at Dehra Dun to carry out the work. On these excellent proposals no action has been taken either by the Irrigation or the Forest Department, nor does the Government of the North-Western Provinces seem to have done anything in the matter. The interests at stake, however, are so important, that it would well be worth while for the leading forest officers in the North-Western Provinces to consider whether they could not carry out part of the scheme. Hitherto the main objection to all such undertakings has been the belief that the ryots themselves burn manure in preference to firewood, and that even cheap firewood would not succeed in replacing that which costs them nothing, while suiting their domestic peculiarities better. To this the reply is that the question has never been put to the test of experiment on a sufficient scale and continued steadily for a sufficient length of time to yield reliable results.

But it is not in the vicinity of the canal only, that plantations ought to be made in the forestless districts of India, in order to provide a more abundant supply of firewood and, especially in seasons of drought, grass and leaves, as cattle fodder. Even in the most densely populated districts the area of waste lands is very large and efforts should be made to utilize portions of this area for the purposes indicated. From the volume of Agricultural Statistics of British India for 1890-91 to 1894-95, compiled in the Statistical Bureau of the Government of India, and which therefore may be supposed to be authentic, I will quote below the area of waste and cultivated lands in a few representative districts in the different portions of the North-West Provinces. In all these districts the column "Forests" is blank. The figures in columns 2-5 relate to 1894-95.

	Waste land. *Unculturable.*	Culturable.	Current *follows.*	Net area cropped *during the year.*	Population per *sq. miles (1891).*
(1)	(2)	(3)	(4)	(5)	(6)
Aligarh	205422	110645	29734	903289	534
Etawah	242289	266039	29423	544615	430
C awnp	403469	264878	50903	789245	512
Azimgarh	322036	168150	59156	826641	805

Taking these four districts together, the waste lands occupy 19,83,000 acres, considerably more than one half of the area actually bearing crops. And the Forest Officers can contribute much towards the better utilization of these large areas, as well as of the waste lands in other districts of the open forestless country.

It seems to me that foresters in India do not sufficiently realize the wonderful faculty which trees have in drawing moisture from the subsoil and maintaining themselves alive during seasons of drought. In such years I of have often stood before a mowha tree or in a mango grove, wondering that they were able

to draw sufficient moisture from the ground when the country around was dry and parched. True, in the driest and hottest districts of the Peninsula, particularly in Cuddapah, I have occasionally found trees of *Anogeissus latifolia*, which had dried up and had been killed, it was said during the years of terrible drought 1876 and 1877. But this was on stony and rocky hillsides, and the fires of the hot season had doubtless added to the effect of drought. This peculiar power of many Indian trees to maintain themselves even in seasons of drought, is the forester's most powerful ally in the operations, the necessity of which, I have often ventured to urge upon their attention.

As regards the supply of cattle fodder, Mr. Hill says: "The soil cannot be covered at the same time by two complete crops—one of grass, the other of trees—and the greater the crop of grass the smaller will be the yield in wood." But he adds: "There must however always be some yield of grass, and while the tree growth is young, this may bring in 8 annas or even a rupee an acre." In this respect the main point seems to me to be, that in dry seasons the shade of trees keeps the grass alive, when in the open it has long ago withered and dried up.

My idea is, that it would be a great advantage, to commence operations on selected areas in the vicinity of the canals so as to gain the needful experience, and to train a number of native forest rangers in this special line of work. Competent men would then gradually become available to undertake similar operations in other districts away from canals under less favourable circumstances. On land adjoining the canals they might work under the Canal officers, but elsewhere the work should be done under the orders of the Collector of the district, the Conservator or other competent superior forest officer having the general control of operations in regard to professional matters, and wherever the cost of these operations is to be charged to Forests, also in regard to money and all personal matters.

These remarks do not apply to Northern India only, they apply to most provinces of the British Indian Empire. The extent of the waste lands, not included within the limits of the Government forests, is enormous; by endeavouring to make these lands more productive, forest officers will be able to contribute much towards the well-being of the agricultural population. Apart from wood, grass and tanning materials, there are many other useful substances that will thus be placed within reach of the people living in the open, and at present, forestless country. The line of action here submitted to the readers of the "Indian Forester" is one step only in the task of further developing the resources of the British Indian Empire, but if adopted and followed, it will prove to have been a most important step of progress.

D. BRANDIS.

BONN,
July 1897.

VI.—EXTRACTS NOTES AND QUERIES

Kaulia Babul in Berar.

The Inspector-General of Forests has been good enough to send me an extract from the working plan of the Loni Range which, from Dr. Schlich's Report of 1883, I gather is situated near Akola giving an account of two varieties of *Acacia arabica.* The same varieties I noticed on a tour through the Berar Forests in March 1877, and will in the first instance give extracts from my diary, as well as a brief account of the specimens collected by me at the that time, and preserved in my herbarium. On my march from Jalámb to Patula on the 5th, I examined several Babul bans in the Akola district near the Purna river. One, the Mattergaon Ban, situated south of the river, between it and the railway, I described in para 177 of my "Suggestions, regarding Forest Administration in the Hyderabad Assigned Districts." Regarding another, my diary states as follows. "On the north side of the Purna examined another Babul ban, on high ground, said to have been formerly cultivated. The trees here were smaller, not more than 12 to 15 ft. high, and the Babul was mostly of the variety with deeply cracked and exfoliating bark and broad marginate pods, which has stouter spines than the common kind and is called here 'Kaulia Babul' It is a decidedly distinct variety, different from the ordinary kind, here called Telia Babul, which has regularly moniliform, narrow pods and smooth bark. The third variety of Babul is the cylindrical (commonly called pyramidal) Babul, know here as 'Ram Kanta'. On my march from Patula *via* Hewarkhar to Jiri at the foot of the Melghat hills, the following day, I find in my diary "fine Babul trees of the three kinds on all fields."

The specimens, which I gathered are in fruit, without flowers, and those of the Kaulia Babul certainly have an appearance very different from the ordinary kind. The spines are white, very stout, at the base $\frac{1}{8}$ inch diameter and up to $2\frac{1}{2}$ inches long, while the spines of the Telia Babul are brown, slender and only up to $1\frac{1}{2}$ inches long. The fruit is flat, on short stalks, very little constricted between the seeds, $\frac{3}{4}$ inches broad, and quite different from the narrow moniliform pods, on stalks $\frac{1}{2}$ to $\frac{3}{4}$ inches long, of the Telia Babul, in which the bridges between the seeds often are only $\frac{1}{6}$ inches broad.

As regards the bark, it must be remembered that the description recorded by me relates to comparatively young trees, otherwise the bark of the Telia Babul could not have been called smooth. For the bark of old Babul trees has always deep narrow regular longitudinal fissures, joined by short cross cracks. That

the bark of young trees of the Kaulia Babul should be deeply cracked and exfoliating ("peeling off" on the specimen ticket) is very remarkable.

So far regarding the observations made by me in 1877. With these observations, the extract from the Working Plan agrees in all points. It contains, however, the following additional remarks: *Telia* has a fairly long bole, smooth bark, small leaflets, the seed ripens in April, grows principally in deep moist soil, and for either timber or fuel is more valued than *Kauria*. *Kauria* (evidently the same as Kaulia) has a shorter bole, very deeply furrowed bark, the seed ripens in January and February. The Loni Range is south of the Purna river, situated I suppose some 18 miles east of the Babul Ban visited by me on 5th March, 1877. Clearly, therefore, the Kauria Babul extends over a considerable portion of the Berar valley.

The value of the Babul tree, which yields fuel, timber, tanning material, gum, lac and cattle fodder; which thrives in the dry climate of the Deccan as well as in the North-West; and which seeds profusely, is easily propagated and coppices readily, is so great and so universally recognized in India, that no apology seems needed for drawing prominent attention to the variations, which it presents. The readers of the "Forester" will, I feel assured, not take it amiss, if I offer a few suggestions for the further study of this subject. It seems to me to be a matter of importance to make a special study of the Kaulia Babul, which may possibly turn out to be a hybrid or a distinct species. The principal Babul forests pure or mixed with other trees, are found in Sind, in the river valleys of Berar and the Northern Deccan, on the black cotton soils of Bellary, Anantapur and Kistana also in Guzerat and in Rajputana, on fields, near villages and on waste land, the tree is however found in most provinces, but disappears when we reach the more humid regions near the coast, and the extreme North beyond the Jhelum, where frost is too severe.

The first point to be ascertained is whether Kaulia Babul is found anywhere else, or is limited to Berar. The second point is, to establish the distinctive characters of Kaulia more completely than has yet been done.

The leaflets are said to be smaller, and this is borne out by the specimens collected by me in 1877. But there are many other points to be noted, the length of the common petiole, the number of pinnœ, the glands at the base of those and the average number of leaflets on each pinna. There may also be differences in the inflorexence, in the flowers and in the seed, as well as in the structure of the wood. The time of flowering of both kinds should be noted more completely than has yet been done. With regard to the statement in the Loni Working Plan, I would observe that on the 5th March the pods of both kinds were not ripe yet, and apparently they were in the same stage towards ripening. The seedlings of both kinds in their course of development should further

be examined and described, and it should be ascertained at what age the tree begins to flower, what size Kaulia attains, and whether it coppices as well as the common kind. Lastly the value of the Kaulia bark as well as of the gum should be determined and it should be ascertained whether the pods are also useful as cattle fodder. Attention should likewise be paid to other species of *Acacia* growing in company with Kaulia Babul. In the Ban north of the Purna river, where I found it on 5th March, 1877, my diary mentions *Acacia eburnea* and *Jacquemonti*. The thought has struck me, whether Kaulia Babul might not possibly be a hybrid between *Acacia arabica* and *eburnea*. The latter has stout, often ivory, white spines, and small leaflets. The pods are flat, slightly contracted between the seed, but only ¼ inch broad. In the Babul bans of the Poona district near the Bhima river *Acacia eburnea* also grows in company with *arabica*, but I find no mention of forms similar to Kaulia Babul in my diary. I would venture to draw the special attention of Foresters in Berar and in the Deccan to this question.

Should these remarks find favour with any reader of the "Forester" in Berar or elsewhere where Kaulia Babul grows, I will add in conclusion, that I should be most thankful for complete specimens with flower and nearly ripe fruit as well as seedling dried at different stages, ripe seed, and small pieces of the wood.

BONN, JULY, 1897. D. BRANDIS.

The advances made in Agricultural Chemistry during the last twenty-five years.

An important address has been recently delivered by Professor Maercker, of Halle, to the German Chemical Society (Ber. 1897, p. 464), summarising the advances which have been made in agricultural chemistry during the last twenty-five years. Professor Maercker pointed out that the term Agricultural Chemistry meant more at the present time than the mere application of chemistry to agriculture, as shown by the fact that the agricultural chemist, in his efforts to assist the farmer, was often more concerned with the biological sciences than with chemistry; while, in addition to his purely scientific work, he was required to take account of economic questions of the day possessing special interest to agriculturists. Some account of the most important parts of the address will be given under the following heads :—I. Plant-food ; II. Soils and Manures ; III. Artificial Selection.

I. PLANT-FOOD.

In supplying nourishment to plants we must know what substances are necessary, and in what form and quantity they should be provided. Little progress was made in our knowledge of the subject till the quite recent introduction of the method of water-

cultures of Sachs, Knoop, and Nobbe, and the method of sand-cultures of Hellriegel, permitted of the conduct of experiments in *pure media, and thus rendered it possible to ascertain not only* what substances are essential for plant life but also the part played by each substance in the plant cell. Thus we know now that phosphoric acid is essential for the formation of nitrogenous substances in the plant, because the albumens, which are of fundamental importance in the transformations of substances in plants, result from an intermediate phosphoric acid compound as is indicated by the *regular occurrence of lecithin in protoplasm. Again*, iron is an essential constituent of chlorophyll and sulphur of albumen, and hence must be supplied to plants. The true function of calcium was for long doubtful ; its action is now known to be of a medicinal character, since it serves to neutralize the poisonous oxalic acid, which is always an intermediate product of the oxidation of the carbohydrates. It was formerly thought that calcium fulfilled some important function in the leaves, being chiefly found in the foliage of plants. Since, however the leaves are also the chief seat of the oxalic acid this distribution of the calcium is easily explained.

The part played by potassium has only within the last three years been explained by Hellriegel, who, by exact experiments with beet-root showed that the amount of sugar in the beet stands in close relation to the amount of potassium provided for the plant. P. Wagner has made the interesting observation that the potassium may be *partly* replaced by sodium.

The exact value of magnesium to plants is not yet well understood, but it appears to be of importance in the formation of the *nitrogenous substances of seeds, as in these* considerable quantities of magnesium phosphate occur.

Nitrogen is an indispensable plant-food, for it is an essential constituent of albumen.

In addition to the quantities of mineral substances required by plants to enable them to exhibit a healthy growth, further quantities are found to be essential to satisfy what has been termed, though not very aptly, the "*mineral-hunger*" of the plant. *This is best* explained by an example. E. Wolff found that for the production of 100 parts of oat-plant (dried), 5 parts of phosphoric acid were necessary, when the remaining mineral substances were supplied in excess to the plant. By other similar experiments he showed that the following quantities of mineral substances were necessary for the production of 100 parts of oat-plants.

Phosphoric acid	·50 parts
Potash	·80 ,,
Lime	·25 ,,
Magnesia	·20 ,,
Sulphuric acid	.20 ,,
...	1·95 parts

A total of 1.95 parts of mineral substances is therefore *necessary* in the case of the oat-plant. However, there is no oat-plant in nature which contains so little as 1·95 per cent. The *minimum* is 3 per cent. The difference, 1·05 per cent., is the measure of the "mineral-hunger" of the plant, and represents the mineral substance which does not perform any special function. This excess of mineral substance may be supplied in the form of some indifferent substance, such as silica. The observation is of considerable interest to the former, for it shows that it is not economical to manure crops with pure substances.

II. Soils and Manures.

Having ascertained in general what substances are necessary as plant-food, the agricultural chemist has next to apply this general information to the manuring of soils which are more or less deficient in certain ingredients. It has been found, unfortunately, that the chemical analysis of a soil is of little use as a guide unless accompanied by what may be termed a "mechanical analysis," by which is meant chiefly a determination of the amount of finely divided constituents present in the soil. It is only the finely-divided earth which presents a sufficiently large surface for the exercise of the solvent action of the water and its dissolved carbonic acid. There is one case, however, in which chemical analysis alone is of the greatest importance, *viz.*: when only traces of some necessary element are present in a soil. Here there is no question of the need for a manure containing this substance.

If, on the other hand, large quantities of an element are present, it does not follow that there is a sufficiency in the soil even when the latter is in a satisfactory state of division, for the substance in question may be present in an insoluble or refractory form. This is commonly the case with nitrogen, which exists in the soil chiefly in the form of a mixture of indefinite nitrogenous substances known as *humus*, or mould These substances sometimes easily give up their nitrogen to plants, but in other cases are very refractory. The uncertainty as to their action is indeed so great that certain peaty soils are known which consist almost entirely of humus, but contain nevertheless an insufficiency of available nitrogen.

Phosphoric acid affords another illustration. The soluble phosphoric acid of the manure is absorbed by the soil as dicalcic phosphate, which is comparatively easily soluble in the soil water. With time, however, it may change in the soil to the insoluble tricalcium phosphate or even to iron or aluminium phosphates which are still less soluble.

In the case of calcium, chemical analysis has been found to be of considerable service in determining what manuring is required, since calcium is chiefly valuable in the form of carbonate or humate, and these are easily estimated in the soil.

Since then the direct method of soil-analysis is an insufficient guide to manuring, it is fortunate that chemists have been able to

develop successfully an indirect method. This is the *cultivation method*, by which plants are allowed to grow in the soil under examination, after taking care to provide a sufficiency of all plant-food stuffs except the one, *e. g.* phosphoric acid, whose presence in available form is being tested. The plants are then analysed, and the results compared with the analyses of the same plants grown on soils provided with all the necessary plant-food stuffs. As an important result of the method it has been found that different plants take up very different quantities of the same mineral substances. On this is largely based the system of rotation of crop where the second crop is so chosen that it chiefly removes the ingredients of the soil which have been left by the preceding crops.

With the aid of the cultivation method it has also been possible to draw up the following table which represents the relative value, of the different nitrogen compounds for plant-food.

Nitrogen of Saltpetre	100
„ „ Ammonia	85-90
„ „ Albumen	60

This table may be made use of in determining the nitrogen value of a manure.

The cultivation method may be used for testing the value of manures of all kinds. Thus it was by a few cultivation experiments that Wagner in Darmstadt first showed the very great value for agriculturel purposes of the "Thomas" Slag, produced as a bye-product in the manufacture of iron by the basic process of Thomas-Gilchrist. The million tons of phosphate meal annually produced in Germany is now wholly utilised by the agriculturist and its preparation for the farmer has become an important off-shoot of the iron industry.

Similarly the demonstration by the cultivation method of the value of potash salts in manures has given an enormous impetus to the potash industry.

Speaking generally, the method gives us complete control over the fertility of a soil in so far as this depends on manuring. One consequence of this has been that our views as to the value of agricultural land have completely changed, for whereas formerly sandy soils were generally considered poor, they are now, by means of a system of intelligently-directed manuring, made to give yields which are scarcely inferior to those of the best soils. The beet-sugar industry, which formerly could only be conducted in the best soils, has now been extended with marked success to sandy soils

It might seem that with a perfect knowledge of the manuring of plants, the need for furthur investigation would cease, for when we have learned easily what each plant requires to attain its highest development we have reached a certain limit. The supply of excessive nourishment is a disadvantage, and only tends to produce sick plants.

There still remains, however, a method by which the fertility of plants may be increased far beyond the limit which nature appears to have fixed. This is the method of artificial selection which has been applied in Germany on the most approved scientific principles. German agriculture would have long since broken down under the stress of foreign competition had it not been for the perfect technology of its agriculturists. As an example, the sugar-beet may be quoted. This plant, which is derived from the white Silesian turnip, and contained originally but a small amount of sugar, could only be used as a source of sugar when the price of the latter was very high. With the fall in price came the urgent need for increasing the percentage of sugar in the beet-root. This was effected by utilising the fact that sugar-richness is hereditary, so that by selecting artificially the roots richest in sugar, getting seed from these, planting the seed, again selecting the richest roots, and so on, a race of plants is at length obtained in which a high percentage of sugar is normal. Accordingly the producers of beet-root seed in Germany have erected great laboratories in which the percentage of sugar in the roots is carefully determined. By applying the principle of artificial selection with regard also to the form and size of leaf and the purity of the sap, it has been found possible to improve the roots from year to year, so that now beet sugar can easily hold its own against cane sugar, and is indeed cheaper than flour, costing as it does in Germany less than a penny a pound.

Similar success has attended the efforts to increase the crops of different kinds of grain. The improvement in malt-barley has been specially marked.

It has been found that plants which have been highly cultivated by artificial selection, easily lose their acquired characters when they are exposed to unfavourable conditions of cultivation; and this has led to many exact investigations, conducted for the most part in Germany, during the last ten years, on the chemistry of plants. The most interesting of these trace the chemical history of nitrogen as it passes from the atmosphere to the soil, then into the substance of plants, and finally back into the atmosphere.

The corresponding cycle for carbon has long been known.

Most plants assimilate nitrogen only in the form of compounds. As however, the total quantity of nitrogen compounds in the atmosphere is comparatively small, there must be some other source of nitrogen for plants. Now the classical researches of Hellriegel have shewn that there is one class of plants, the *Leguminnosæ*, or nitrogen collectors, which are able to assimilate elementary nitrogen and so to leave a soil in which they have been grown richer in nitrogen compounds. It has been found that the power of acting as nitrogen collectors is always associated with the presence of micro-organisms on the roots, and that the assimilation of the nitrogen is in some way not understood due to the micro-

organisms. The recognition of the power of leguminous plants to act as nitrogen collectors is manifestly of great practical importance, for it shows clearly that the best rotation of crops is one in which a leguminous crop is followed by one of nitrogen consumers, *i, e.* plants which cannot assimilate nitrogen directly.

Leguminous plants, whether first used for fodder for animals or simply left to decay in the soil, have their albumen changed in the first instance to amides, which under the influence of ammonia ferments are decomposed with formation of ammonium-carbonate. The saltpetre bacillus then converts the ammonium-carbonate (and probably also amides) into saltpetre, *i. e.* into the best form of nitrogen plant-food.

Unfortunately the whole of the nitrate thus formed is never available for plants, on account of the destructive action of the nitrate—destroying bacilli, which decompose the nitrates with evolution of free nitrogen, and so complete the nitrogen cycle.

The nitrate destroyers are usually present in stable manure, and cause a deplorable loss to agriculture, amounting in Germany to a sum of several million pounds annually,

Efforts which, as Professor Maercker assured the German Chemical Society are likely to meet with success at an early date, are being made to aviod this loss ; and for this purpose special bacteriological investigations are now being conducted at many agricultural stations in Germany.

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India Rubber.

In an article on India Rubber in the "Indian Agriculturist" of the 1st September, we notice an extract from a paper by Mr. J. R. Jackson, which appeared in "Nature," Vol. 55, page 610. Except where this paper may be taken to refer to the few artificial plantations that have been established, it is, we regret to say, far from accurate; for it talks of the *Ficus elastica* forming large forests in India and Ceylon, while, as far as our Indian experience goes, we only find this species very sparingly interspersed in evergreen forests. The *Ficus elastica* is not sufficiently shade-enduring to permit of its germination and growth on the ground. The seed no doubt germinates very freely in the forks of trees where a little mould or *débris* has accumulated, but in order to permit the young plant to establish itself and to become sufficiently strong to form a connection with the soil below, it is absolutely necessary that the tree on which it finds itself placed should be either dead or diseased. If not the young *Ficus* cannot obtain sufficient nourishment, and dies. That this is the case has been clearly established by experiments in the Charduar rubber plantations. Here many hundreds of *Ficus* were planted in the forks of trees. They were supplied with a considerable quantity of soil and grew to be healthy plants; but they lived the life of pot plants, and after more than 10 years not one of those growing on a healthy tree had established its connection with the soil. Now, even in a virgin evergreen forest, the majority of trees are neither dead nor so unhealthy as to yield sufficient nourishment to the *Ficus elastica* till it has become connected with the soil and established itself as an independent tree; and the "*veritable forest of trunks*" remains a thing to be wished for, but does not exist in nature.

As regards an entirely artificial rubber plantation, Mr. Jackson's description is perfect. In fact over acres of such plantations the roots of the trees, in some instances planted 100 feet apart, have not merely become interlaced but have amalgamated, and acres and acres may be said to live, so to say, on one great root.

Kumri Teak Plantations.

In hopes that this method of regeneration in our Indian forests may interest some of the readers of the "Indian Forester," I venture to give the few following notes of what we have been doing in Coorg during the last few years. I do not think I am far wrong in saying that Coorg is the first place in India where "kumri" is being made use of on a large scale in the growing of teak, and lately of teak and sandal together. It is needless for me to go into details as to what "kumri" is, as no doubt all foresters are well acquainted with the "taungya" of Burma, and Kumri is only another name for it. Kumri teak plantations were first started in Coorg in the rains of 1891 on a small scale, when an area of about 17 acres was planted out with teak in the Mawkal Reserved Forest. Since then this system of planting out teak has been extended to other forest blocks and has now reached 393 acres.

Kuramba Forest Villegers.

The "kumri" clearings are made by Kurambas, an aboriginal tribe who love nothing better than this method of cultivation, and ever since the "kumri" has been started, I have found them coming to our forests in fair numbers and forming small "hadis," the local name for a collection of Kuramba huts. It can hardly be called a village, as a Kuramba is not fond of encumberances, and enjoys the freedom of being able to shift at a moment's notice. He is by nature very lazy, and hard work does not suit him for long, so that he requires most gentle handling, but on the whole his services are invaluable to the forests in Coorg, where his is the sole labour that can in any way be depended on. Now that he and his family have taken kindly to the planting of teak in his Kumri, every encouragement is given him to settle in regular selected sites within the forests. There is always the danger owing to petty annoyances from the forest establishment, of a batch of these men leaving the forest, for this method of planting is not in favour with some of the subordinates who would much like to see it stopped and the old system of planting taken up again, the results of which were not satisfactory and the expenditure high. The Kuramba's only regular crop is "Ragi" "*Eleusine corocana.*" For this he prepares the ground by cutting all forest growth in the area selected for him. This is done in January, after he has helped to clear the firelines of the forest within which his "hadi" is located. In April or May, according to it being a dry season or not, he sets fire to the area after carefully making a fire trace round it. This occupies him, to do it properly, from 8 to 10 days, allowing for cutting and heaping up stuff not properly burnt. The land is then quite ready for sowing, but before the sowing he and his family carefully stake out the area, where the young

teak plants are to be put out later on, each man doing his own plot. After one or two monsoon showers, early in June, the Ragi crop is sown broadcast, the ground having been first slightly worked up by a light hand hoe. As soon as the crop is sown the young teak plants which have been raised in a nursery made by the Kurambas themselves, are put out at stake by the men, women, and children.

Teak Nurseries.

These teak nurseries are made by the Kurambas close to their "hadis." The seed is collected departmentally and given to the men early in February, a small area is then well worked up by them near water and the seed sown thickly in the prepared bed, a coating of straw is placed over it, and the whole kept well watered by the women and children. Each house has its separate little plot in the nursery, by mutual arrangement. It is astonishing how kindly these men have taken to this part of the work, considering the short time they have been at it. I have never found the nurseries neglected and they are always kept well watered. The seed put out in February and March begins to sprout by the middle of April and May, and by the time the young plants are put out, during the latter part of June, the seedlings are from 3 to 4 inches high and some even 6 inches and more.

Kumri Teak Plantations.

When the crop has been sown and the young plants are all in place with the rain coming down, as it well knows how to in Coorg, the men of the "hadi" are most of them engaged in the coupe fellings, for nearly all our forests here are under working plans. But it must not be understood that because the men are away, that the area on which the crop is sown and the teak planted goes untended, far from it, the women and children are seeing to this. The first weeding begins about the last week in July and is kept steadily going right through to the flowering of the Ragi, and it is no easy task to keep down the weeds. There are other difficulties to be contended against, which if neglected for a single night are almost sure to ruin the whole field. All the forests where the Kurambas have taken so kindly to the work are overrun with herds of wild elephants, and notwithstanding the numbers caught by the Mysore Kheddas from the adjoining forests, the elephants are still found in fair numbers. Deer also are very destructive in these quiet secluded forest clearings; so that the Kurambas have by no means an easy time of it, and are bound to keep both a night and day watch over their crops. As the area of Kumri goes on extending the men, still retaining their "hadis," build for themselves, each near his own plot, nice little shelters where they live for the four or five months during the time the crop is down and uncut.

Payment for plants raised.

As noted above, the current year's teak plants put out get well weeded with the weeding of the crop. These plants are not paid for during that year, and are still under the care of the Kurambas who planted them till August of the following year, when they get a final weeding and are counted and paid for at the rate of Rs. 1-4-0 per 100 plants on the ground. That is, the young seedlings get the benefit of a two years' weeding, besides the raising and planting, for Rs. 1-4-0 per 100 plants alive. This, if I am not mistaken, is a more favourable arrangement than that of Burma, where the plants are counted and paid for at the end of the first rains. I may be mistaken, as I have not seen any paper on Burma taungya. However, the arrangement is a most satisfactory one for a small place like Coorg, where labour is so very expensive, owing to the numerous coffee estates adjoining.

The teak plants are put out at a distance of about 6 ft. by 9 ft. and it may be argued that this distance is much too close, but allowing for a certain amount of failures, I would not advocate, at least for the present, the planting to be farther apart. The number of plants raised per acre and paid for has been from 600 to 800 and the Rs. 7-8-0 to Rs. 10 hitherto paid must be considered moderate. Of course it is needless for me to mention that the Kurambas get the crops raised on the area free of any assessment.

To stimulate a certain amount of competition among the men, I have introduced during the last three years a small prize for the man showing the best results during the year of payment, which has, I am happy to say, taken most favourably, and by this means the second year's weeding before the payments are made, has received great attention, with very good results.

Weeding.

I have given above the life history of these teak plants for the first two years. It must not be inferred from this that the idea is to convert the whole area into pure teak forests, which for Coorg would be a mistake. During the second year's weeding such stool shoots of Terminalia, Dalbergia latifolia, Pterocarpus, Lagerstroemia microcarpa and one or two of the other good forest trees are not cut back, and such seedlings of the above species as may have sprung up are also left. While on this point, I should like to mention a fact in connection with Dalbergia latifolia, and that is its great vitality in not only sending up stool shoots, no matter what the size of the tree may have been, and the abundance of root shoots that spring up right round the parent stools in these burnt areas.

After the second weeding the teak plants have to be tended departmentally, and weedings have, over a good part of the area, to be done most carefully for at least another 3 years. Bamboos

(Bambusa arundinacea), inferior species such as Kydia, Sponia, climbers and the ever spreading lantana have sprung from the old clumps and stools and shoot ahead. It may be asked, why lantana is mentioned here ; simply because though generally a shrub, it has when it gets a young tree handy, a nasty habit of becoming a regular climber and will in time choke out its support, as it spreads most luxuriantly over the branches, and forms a most dense crown over the saplings. All these have most carefully to be kept down in the Kumri plantations until the teak has made some headway and got a fair start. An average of Rs. 2 per acre yearly is sufficient for this work for the three years, and then the teak in Coorg is left alone.

Results obtained.

The Kumri plantations have up to the present been solely confined to the Reserved Forests along the eastern border of Coorg, adjoining the Mysore country, and have steadily been increased since 1891, each year showing a larger area worked. And as parties of Kurambas keep coming in with their families and are being located in fresh forest blocks, the work is satisfactorily progressing. The area of plantations has now reached 393 acres, which considering the difficulties that had to be encountered is very good. The results of the planting are also all that can be desired. I have measured a number of saplings and obtained an average for plants put out in 1891 of 6 inches girth at 5 ft. from ground and 15 feet in height. I have also in this same area measured a number of saplings 12 inches girth and 20 feet in height. These measurements speak for themselves, the growth being that of 6 years. I expect even better general results from the Kumri plantations taken up since 1895, the young plants having an average girth for the two years of 2½ inches at 1 foot from the ground and 6 feet in height, some of the largest measuring 4 inches in girth and 10 ft. in height. With these figures before one, it can hardly be questioned that the results are not a success with a minimum of cost.

I have stated above that kumri has hitherto been confined to the eastern zone of the Coorg forests. In the Nalkeri forest where the rainfall is 66 inches, 241 acres are under Kumri plantations. In the Mawkal Forest the rainfall is 45 inches, and 130 acres are under " Kumri, while in the Dubare forest still farther north, were the rainfall is only 36 inches, and where Kumri was started only last year, the area is 22 acres.

In the Ghat Forest to the west when the rainfall varies from 120 to 145 inches, a Kumri plantation has been started through the kind help of one of the planters, who has a cardamom estate adjoining the forest, and Kurambas who have no work during the greater part of the rains have taken this up for me. I am very hopeful of success here also.

SANDAL AND TEAK KUMRI PLANTATIONS.

Having, during the last three years seen that teak succeeded so well in Kumri, I started a small area of Kumri plantation in which I got the Kurambas to dibble in sandal seed along with "*togri,*" *Cajanus indicus, in lines 10 feet apart,* with "ragi" sown in between the lines. The sandal was kept well weeded right through last rains, while the "togri" helped to protect the young sandal seedlings through the dry weather. The results I might say, when seen by me the other day, are marvellous for sandal. The plants average 1 inch girth at 1 foot from the ground and have an average height of 3 ft. 6 in., the largest running to 1½ inches in girth and 6 ft. 6 in. in height. This I considered good enough to permit of my going in for sandal kumri plantations on a larger scale, so I have combined it with teak on 17 acres *in the Dubare Forest. The teak is put out about 7 feet apart* in lines about 15 feet apart, and a line of sandal dibbled in between the two lines of teak, which gives alternate lines of teak and sandal. I have seen sandal under teak and it does very well. Another great advantage will be the protection of the young sandal plants from being eaten up by deer, besides having the benefit of two years' weeding. When last seen these 17 acres of sandal and teak kumri plantations, right in the depths of the forest with the little kuramba huts dotted about, were a most pleasing sight. I took the opportunity of counting the teak plants put out at the *beginning of the rains on the 17 acres, and they amounted to 500* good strong plants per acre, so that even if the sandal is not a success, of which I have no fear, there will be a sufficient number of teak plants on the area.

GENERAL FACTS NOTICED.

Before closing these notes I would mention that nearly all the young teak seedlings put out during the first rains die down in the hot weather, only to throw up a vigorous shoot during the next rains. This is more noticeable in the larger plants put out, those of 6 inches in height and over.

Another fact in connection with teak plantations deserving of careful note in Coorg, is that all teak saplings after they have attained a height of over 15 feet have their side branches attacked with canker, which as the tree keeps on growing, invariably kills out the branches Fortunately in no single instance do I recollect to have seen the leading shoot thus attacked. The disease is most prevalent in our old regular plantations where every tree is covered with cracked knobs on the branches which are dead and dying. I have mentioned this fact, because I see that the disease has made its appearance in the teak Kumri plantations of 1891 and 1892. What effect it will have on the growth of the teak later on remains to be seen and will be carefully watched.

A. E. LOWRIE.

Notes on Minor Forest Produce and their Development and Utilization. By Mr. A. E. Wild, Conservator of Forests, Bengal.

Mica.

There has been a large development in this industry, 44 new mines having been opened out during the year under report, out of a total of 222 now in existence, while applications for 22 more are under consideration. The lease of 27 mines, rented at Rs. 225 only, expired during the year and has not yet been renewed. As hinted at last year, the Department does not appear to obtain its full share of this lucrative trade and it is intended to take the matter up in earnest during the coming cold weather. A sum of Rs. 8,249 has been credited to the Department on this account during the year, againt Rs. 7.607 in 1894-95. These figures represent, however, the revenue from the reserved forests only, enquiry showing that, for some reason

not yet known, the receipts from the protected forests have been credited by the Deputy Commissioner to "Miscellaneous Land Revenue."

The demand for the current financial year is:—

Reserved forests ...	... 9.025	=Rs. 12,343
Protected do ...	... 3.318	

and will, undoubtedly, be increased.

The area covered by these 222 mines is, 141 acres, while the output is estimated at 5.4ᵇ6 maunds valued at Rs 2,72,545. These figures have been procured by the Deputy Commissioner from the lessees; it is evident they cannot be relied on, both the output and market value must be considerably higher.

Quoting from these figures, it is not, however, too much to say that the landlord, Government, is satisfied with a very small percentage on the market value of the mica worked, *viz.*, 5 per cent. The cost of procurement is exceedingly small, and the profits accruing to the leaseholders must be extremely handsome.

Sabai grass (*Ischæmum angustifolium*).

This commodity is still in great demand for the manufacture of paper. During the year the following quantities were imported into Calcutta, Raniganj, &c:—

	Mds.
From Singhbhum forests	... 55,000
" Sahibganj "	... 3,03,289
Total	... 3,58,289

The only other centre of any importance for Calcutta is Nepal. the exports from which country are unfortunately not available. Of the above quantity, the Department was credited merely with royalty on that from Singhbhum. Though the Sahibganj supply is all drawn from plantations made by the Paharias of that part of the Sonthal Parganas district on the protected forest area which they have cleared of wood and planted with sabai, Government has not as yet derived *any income whatever* from this industry, not even land tax, the middlemen, the mahajans, and Biparis reaping all the spoil. The sabai fields are within easy distance of the town, where the grass sells readily unbaled at 12 to 14 annas a maund. At the mills the average rate is Re. 1-4 to Re. 1-7 per maund, railway freight being not over 3 annas 5 pies a maund! Since the Department has taken over the forests of the Sonthal Parganas district, the subject is receiving attention. Were, Government to fix a royalty of even one anna per maund only its revenues would be increased by Rs. 18,955.

Large presses with steam power work here night and day in the season, and the gathering and carriage of the grass affords labour to hundreds of the population. As the subject is one of great importance, the following extract is given from the Report

of the Director, Botanical Survey of India, for 1894-95 :—"Sabai or babar grass has proved amenable to cultivation so far as to yield a small crop at the rate of two tons dry grass per acre, with slight irrigation and a quantity of seed which is being offered to the public, gratis." Perhaps Mr. Duthie was unaware of the large extent of sabai under cultivation at Sahibganj, all raised from transplants some years ago!

Though the demand has not probably shown much fluctuation since 1893-94 the income of the Department has risen in a most satisfactory manner, and will most certainly continue to increase. The figures are—

			Rs.
1892-93	...	...	1,750
1893-94	...	...	2,714
1894-95	...	...	4,268
1895-96	...	...	*6,336*

It is rumoured that another grass has been found equal to sabai, but the information is doubtful. However, when it is understood that the Calcutta mills turn out 360 tons of paper a week, or an equivalent of say, 5,00,000 of maunds a year, there is room for wood pulp as well as another grass. It is understood that a consignment of 200 tons left Calcutta for Glasgow during the year at £ 4-2 a ton. If the cost can be reduced to £ 3-10 and there seems no real reason why it should not, it will, as mentioned in paragraph 84 of last report, undoubtedly compete with *Esparto.*

Kamela dye (*Mallotus philippinensis*).

This product is now for the first time treated of separately from other produce with which it has hitherto been classed. During the year a consignment of 30 seers was sent to Messrs. Gehe and Company, of Dresden, through the kind offices of Dr. Watt, the Reporter on Economic Products to the Government of India ; it was most favourably reported on and resulted in an order for 20 cwt. The rate charged—Rs. 25-5-4 per maund—was fixed by Messrs. Gehe and Company themselves, and was lower than the Indian market price (the consignment being merely a trial one). The transaction, therefore, resulted in a slight loss, the account standing thus :—

		Rs.	A.	P.
30 seers	Price realized ...	19	0	0
	Cost of collection, carriage, &c.	23	1	3

But Lisboa remarks :—"The article Kamela finds a ready market, and is now worth one shilling and six pence a lb. ;" this is equivalent to Rs. 102 a maund, and the rate, therefore, was charged much too low. This is the first venture of the Department to secure a home, or indeed, almost any market, and while no doubt there is a large local demand for really good stuff, shows

what can be done when conducted in earnest. Samples were retained in the Indian Museum, Calcutta (4½ seers) as well as forwarded to the Imperial Institute, London (5 seers).

Tannins

An experiment was made in the Sundarbans Division to obtain a solid extract of the bark of the mangroves, and samples were forwarded to the Reporter on Economic Products to the Government of India.

Two analyses for tannins of *Rumex Nepalensis* were carried out by Professor Trimble of Philadelphia and by the Agricultural Chemist to the Government of India. The result gave 5·5 to 6·3 per cent., which are not sufficiently favourable to give the root any practical value as a tanning agent. The reactions indicate the tannin to be identical with that from oak bark. For his interest in the tannins the Conservator was, during the year, elected as a corresponding member of the Philadelphia College of Pharmacy.

Fibres.

Enquiries have been made (as a substitute for the true rhea) for ribbons of a nettle common to the forests above 3,000 feet, and a contract entered into at a very low figure; but as the result is still problematical the species is not communicated.

There seems every probability of creating a market, both home, perhaps, as well as local, for a fibre hitherto but little known, which grows in enormous quantities in certain tracts. Reports so far received are very highly favourable, and it would indeed seem probable that through the kind instrumentality of Dr. George Watt, the Reporter on Economic Products to the Government of India, to whom the sincere thanks of the Conservator are due for the very valuable assistance at all times accorded in the development of the minor products of the Bengal Forests, a means of utilizing the immense supplies of this product has at last been found.

Match wood

No less than 23 samples of different kinds of woods have been sent to the Bengal Safety Match Manufacturing Company, *Limited, Calcutta, for experiment*, and some 11 kinds have been pronounced as suitable for the manufacture of matches, but so far no practical results have ensued."

The following statement gives the details of outturn for the year including estimated removals by privileged villagers :—

Class of forest and agency by which produce was removed.	Timber.	Fuel.	Bamboos.	Minor produce.
Reserved	C. ft.	C. ft.	No.	Rs.
Government ...	194,585	95,606	14,757	242
Purchasers ...	4,451,933	12,266,470	7,142,692	1,01,843
Free grants ...	3,001	21,624	......	559
Right-holders ...	......	1,389,185	683,200	8,211
Total ...	4,649,519	13,772,885	7,840,649	1,10,855
Protected.				
Government ...	10,757	6,436	83,555	4
Purchasers ...	338,738	4,267,219	359,926	23,036
Free grants ...	5,083	......	900	19,361
Right-holders ...	184,030	14,463,312	4,000,000	1,67,259
Total ...	538,608	18,736,967	4,444,381	2,09,660
Unclassed.				
Government ...	9,483	2,837	6,725	.....
Purchasers ...	359,870	172,270	8,408,808	8,349
Free grants ...	......	......	.....	......
Right-holders ...	......	......	......	......
Total ...	369.353	175,107	8,415,533	8,349
GRAND TOTAL IN 1895-96	5,557,480	32,684,959	20,700,563	3,28,864
GRAND TOTAL IN 1894-95	4,493,234	30,195,622	22,049,274	2,72,942
Difference in 1895-96 ...	+1,064,246	+2,489,337	—1,348,711	+55,922

Financially the year was the best on record, as may be seen from the following table.

Financial year.	Receipts.	Charges.	Net Revenue.
	Rs.	Rs.	Rs.
1891-92	7,89,553	4,22,930	3,66,623
1892-93	7,44,882	3,81,608	3,66,274
1893-94	8,01,011	4.04,043	3,97,568
1894-95	7,95,673	3,98,601	3,97,072
1895-96	9,18.709	4,66,068	4,52,641

The increase under receipts was notably under timber and fuel in the Sundarbans and Darjeeling divisions. The increase under charges was due to the departmental sleeper work in the Singbhoom, Kurseong, and Angul divisions, to increased expenditure on roads and buildings, and to there being two supernumerary gazetted officers on the Bengal list. Of the divisions, Darjeeling, Tista, Kurseong, Jalpaiguri, Sundarbans and Chittagong show a surplus; while Buxa, Sonthal Parganas, Palamau, Singbhoom, Angul and Puri show a deficit, The total surplus of the Sundarbans Division was Rs. 4,63,961 or more than the total of the whole circle.

VI.—EXTRACTS, NOTES AND QUERIES

The Exudation of Gum from Fruiting Stalks of the Mahua.

An interesting phenomenon with regard to the Mahua tree which hitherto seems to have attracted little attention has recently been noticed in the Hoshangabad Division of the Northern Circle, Central Provinces. The Divisional Forest officer records that, after the fall of the mahua flower this year, a peculiar substance of the consistency of gum was observed to exude from the fruiting stalks. It is described as very sweet and sticky and tasting like toffee. In the above division it appears to have occurred in large quantities and was greedily consumed by the poor people. On further enquiries being made in other Divisions, little or no information on the subject could be obtained, indicating that the phenomenon is either of periodical occurrence or, if annual, confined to a few localities and certain isolated individuals. In the Jubbulpore Division, a kind of 'milk' or gum' is said to exude from the stalk after the mahua fruit has fallen but the excretion occurs in small quantities and only on a few trees. The phenomenon is described as being of yearly occurrence in the Betul Division and in two Ranges of the Mandla Division but this assertion is based on information obtained from subordinate officers and Gonds. From four other Divisions no information at all on the subject could be obtained. Hence no details are at present available as to the exact place of origin of the exudation, whether from the scars left by the fallen corolla, from the end of the shoot after the fall of the fruit or from some specially developed secreting tissue, whether the exudation is noticed when the flower has not been fertilized, whether it ceases soon after the fall of the flower or continues during the maturing of the fruit, whether the phenomenon is noticed on individual trees or only on certain branches of different trees, and whether it is of yearly occurrence or

particularly prevalent in certain years remarkable for drought or otherwise. However, now that attention has been drawn to the subject, it is to be hoped that observations will be made, where possible, for the purpose of supplying reliable information concerning these and other details, as the subject in an interesting one.

R. S. HOLE,
Asst-Conrs. of Forests, Jubbulpore.

Chinese Insect White Wax.

In the August number of the United State Consular Reports a very interesting account is given of that curious substance known as Chinese Insect White Wax which until quite recent years was one of the most mysterious of the many mysterious industries of China. Some years ago, Mr. Baber, of the British Consular, service in China, published an elaborate report on the subject, based on information which he obtained during many years of residence and travel in Western China; but this report, interesting as it was, has by this time shared the fate that speedily attends all official publications, and therefore, we need not apologise for referring to this new report of Mr. Smithers, the American Consul at Chungking, the commercial capital of Szechuan.

Chinese books nearly four hundred years old mention the wax, but at that time, the notion was that the insects did not excrete the wax, but were themselves, by some strange metamorphosis, converted into a white substance which became wax. Although Szechuan province is the chief breeding ground of the insect, and the centre of the production and manufacture of the white wax of commerce, the wax is found in most of the other provinces of China. A little to the west of the 102nd degree of longitude, the Yangtsze is joined by the Yalung river; the united waters flow south-eastwards below the 26th degree of north latitude, and again turn north forming a great loop the outer side of which is turned towards Yunnan. Before the Yalung joins the Yangtsze, it is itself joined by a stream called the Anning, which flows down the Ning-Yuan valley, Ning-Yuan being the chief town of the Yangtsze loop already mentioned. This valley is the great breeding ground of the white wax insect. It is about 6,000 feet above the level of the sea, and on the hills bounding the valley is one very prominent tree, called by the Chinese the insect tree. It is an evergreen with leaves springing in pairs from the branches They are thick, dark-green, glossy, ovate and pointed. At the end of May or beginning of June, the tree bears clusters of small, white flowers, which are succeeded by fruit of a dark purple colour· The authorities at Kew have decided that the tree is the

Ligustrum lucidum, or large-leaved privet. In March numerous brown pea-shaped excrescences are seen attached to the bark of the boughs and twigs ; the larger ones, or scales, are easily detachable, and when opened, present either a whitish-brown pulpy mass, *or a crowd of minute animals, like flour, whose movements* are barely perceptible to the naked eye. In May and June, the scales when opened are found swarming with brown creatures crawling about, each provided with six legs and a pair of antennæ. Each of these was a white wax insect. Many of the scales also contained either a small white bag, or cocoon, covering a pupa, or a perfect imago, in the shape of a small black beetle. If left undisturbed in the broken scale, the beetle, which, from its ungainly appearance, is called by the Chinese the buffalo, will, heedless of the wax insects which begin to crawl inside and outside the scale, continue to burrow *in the inner lining of the scale*, which is apparently its food. The Chinese declare that the beetle eats the wax insects, or at least injures them by the pressure of his heavy body ; and it is true that scales in which beetles are numerous are cheaper than those in which they are absent. The beetle, in fact, is a parasite on the wax insect, and the grub, not the imago, is the enemy of the wax insect. When a scale is plucked from a tree, an orifice where it was attached to the bark is disclosed. By this the insects are enabled to escape from the detached scale.

Two hundred miles to the north-east of Ning-Yuan valley, and separated from it by a series of mountain ranges, is the prefecture of Chia-ting, within which insect white wax, as an article of commerce in produced. At the end of April the scales are gathered in the Ning-Yuan valley, and collected mostly at the town of Te-Chang, on the Anning river already mentioned. To this town porters from Chia-ting resort annually in great numbers—as many it is said, as ten thousand,—to carry the scales across the mountains. These are made up into paper packets, each weighing about a pound, and sixty of these make the usual load. Great care is taken in transit. The porters travel at night, for the temperature is high enough during the day to cause rapid development of the insects, and lead to their escape from the scales. At the resting places, the porters spread out the packets in cool places ; but in spite of these precautions each packet is found to have lost an ounce in weight on its arrival at Chia-ting. In years of plenty the pound of scales laid down at Chia-ting costs about half-a-crown; but in a year of scarcity, like last year when only a thousand loads reached Chia-ting, the price is doubled. In favourable years, a *pound of Chia-ting* scales is calculated to produce from four to five pounds of wax ; in bad years little more than one pound is to be obtained, so that the industry has a considerable element of risk.

West from the right bank of the Min river, on which the town of Chia-ting lies, stretches a plain to the foot of the sacred Omei-mountains. This plain is an immense rice-field, and is well

watered with streams from the western mountains. Almost every plot of ground on the plain, as well as the bases of the mountains, are thickly edged with stumps, varying from three to a dozen feet in height, with numerous sprouts rising from their gnarled heads. These resemble at a distance pollarded willows. The leaves spring in pairs from the branches. The tree is known to the Chinese as the white wax tree, and it is to these trees that the scales are brought from the Ning-Yuan valley. On their arrival about the beginning of May, they are made up into small packets, of twenty or thirty scales, which are enclosed in a leaf of the wood-oil tree, the edge of the leaf being tied with rice-straw, by which the packet is suspended close under the branches of the wax tree. A few rough holes are drilled in the leaf with a blunt needle so that the insects may find their way through them to the branches. They emerge and creep rapidly up the branches to the leaves, where they nestle for thirteen days. They then descend to the branches and twigs, where the females develop fresh scales in which to deposit their eggs, and the males to excrete the substance known as white wax. This first appears as a white coating on the lower sides of the boughs and twigs, and resembles sulphate of quinine or a covering of snow. It gradually spreads over the whole branch, and after three months attains a thickness of about a quarter of an inch. When the white deposit becomes visible on the branches, the farmer goes round belabouring the stumps with a heavy wooden club during the heat of the day, to rid the trees of enemies of the wax insect. After a hundred days from the placing of the insects on the trees, the deposit is complete; the branches are lopped off and as much of the wax as possible removed by hand. This is placed in an iron pot of boiling water, and the melting wax rises to the surface, is skimmed off and placed in a round mould, whence it emerges as the white wax of commerce. The twigs and branches are then thrown into the pot, and the wax thus obtained is darker and inferior. Finally, the insects, which have sunk to the bottom of the pot are placed in a bag, and squeezed until they have given up the last drop of their valuable product, when their short and industrious career is closed by their being thrown to the pigs. As this process destroys all the scales, and all chance of a new generation of insects, it is necessary to have recourse yearly to the Ning-Yuan valley for fresh scales with eggs or insects.

Since the use of kerosine oil has become almost universal in China, the demand for white wax has decreased considerably and the supply has naturally declined in the same ratio. The ten thousand porters once necessary to carry the scales over the mountains, are now reduced to a thousand; and now candles are used only in the lanterns which people carry when going about at night. Twelve years ago, 454 tons, valued at about £200 a ton reached Shanghai from the Yang-tsze ports; not long before this, the price was double that quoted here. In Western China the sole

use of the wax is for coating the exterior of animal and vegetable tallow candles, and for giving greater consistency to these tallows before they are manufactured into candles. The insect white wax melts at 160 degrees F., while animal tallow melts at about 95 degrees F. Hence vegetable and animal tallow candles are dipped into melted white wax; they thus get a coating which prevents them from guttering when lighted. The white wax is used in the other parts of China as a sizing for paper and cotton goods, for imparting a gloss to silk, and as a furniture polish Chemists are also said to use it for coating their pills, and in certain of the coast provinces it is used to impart a polish to steatite, or soapstone, ornaments after the carving is completed. "Such then," concludes Mr. Smithers, "is a brief history of the production, manufacture, and uses of Chinese insect white wax, a substance interesting from a biological, as well as from a commercial, point of view."—*Rangoon Gazette.*

The oldest Poplar in France.

The citizens of Dijon, France, recently voted a sum of money for putting a railing round a tree standing within the city limits. The tree bears a label which informs the sight-seer that it is the oldest Poplar in France. The Town Council has a record tracing the history of the tree since the year 722 A. D. It is 122ft. in height and in circumference.—*Scientific American.*

The Australian Salt Bush.

Professor Hilgard of the California State University says that the Australian Salt Bush can be grown successfully on arid and Jalkali lands; that it removes from the soil large quantities of Sodium carbonate and Sodium chloride, the two most injurious alkaline salts. In soils therefore, where the percentage of alkali is near the danger point they may be sensibly relieved by planting salt bush for several seasons. The yield is nearly equal to that if Alfalfa.—*Scientific American Supplement.*

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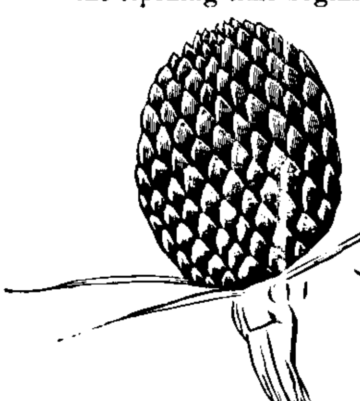
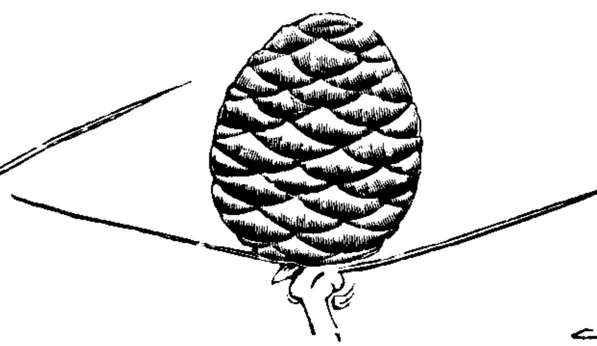
The Fructification of the Deodar.

Our correspondent "S. A. C." sends us the following note :—

" I have made during the last 12 months a most careful study
' of the fructification of Deodar, which may interest you. Both
' male and female flowers appear first with light brown covering
' sheaths. The covering sheath opened in 1897 as regards the
' male flowers from the 25th July, and in a very few days the
' majority of male flowers appeared. However, there were some
' late individuals and some only come out in the end of August.
' The first female flower I observed naked was on the 1st Septem-
' ber. There is no difficulty in recognizing the female even in the
' early stages of growth, and in fact with a magnifying glass its
' characteristics can be ascertained when still enveloped by its
' sheaths. In the male flowers the scales are closed up from the
' very beginning (*Fig I*). In the female flower they are gaping
' (*Fig II.*). There is very little difference in the general shape at
' the outset, which can be seen by comparing the female with a late
' appearing male ; but of course when the female appears, the
' majority of males have already assumed an elongated shape.
' When the pollen is shed, the females are moist and the pollen
' sticks to them. They then seem to assume a little rounder ap-
' pearance for a fortnight or so, and then the growth comes to a
' stop till the following March, or is at least imperceptible. From
' March to the end of August they increase in size and then
' the ripening time begins.



Young male Cone.
Much enlarged.



Young female Cone before fertilisation.
Much enlarged.

'In the majority of cases males and females are on separate 'trees, but they are also found on the same tree, when, as a rule, 'the females occupy the lower and the males the upper branches. 'I have never observed males and females on the same branch. As 'regards this, I have been contradicted, but people did so from 'memory only, and as yet I have had no proof that my observation 'is incorrect."

During a recent tour in the Jaunsar Forests, a very large number of Deodar trees were examined and the results fully confirm the observations contained in the last paragraph. The number of trees found with only male cones was very largely in excess of those with female cones or with both, and from all accounts it appears highly probable that many of the trees never produce anything but male cones. If this should prove to be the case, the importance of ascertaining which are the female trees and marking them before any fellings are made, becomes at once apparent, and we hope that other officers will further investigate the matter and inform us of the results.

The After-training of Coopers Hill Men.

In our last issue there appeared a letter from "Scrutator" in which he recommended that every young forest officer should, on joining, undergo a further course of a year's training at Dehra Dun. The subject is hardly a suitable one for discussion in these columns, but as we have seen "Scrutator's" letter quoted as representing the views of the "Indian Forester" we think it desirable to state that in our opinion there are a number of considerations which render "Scrutator's" proposals altogether impracticable.

We quite agree with him that men without sufficient experience should not be pitchforked into the charge of Divisions, and that newly joined forest officers should not be stationed in places where they have no opportunity of learning the ordinary operations of forest work. But if such things happen, it is the fault of the Conservators who advise Government in regard to the posting of officers, and the remedy lies in their own hands. There are in all provinces some Divisions which are more advanced than others and the newly joined forest officer should invariably be posted to one of these, and kept there until he has gained sufficient practical experience and is able to make himself understood in the language of the country.

We would also enter a protest against the sweeping condemnation of the Cooper's Hill trained men implied in the first paragraph of "Scrutator's" letter. We have come across a good many of these men and we cannot call to mind a single one who has shown a dislike for his work; in fact our experience has been quite in the opposite direction.

III.—OFFICIAL PAPERS & INTELLIGENCE.

India Rubber in Assam.

A brief account of how rubber trees (*Ficus elastica*) are grown in Assam. By Mr. D. P. Copeland, Deputy Conservator of Forests, Darrang Division.

1. *Ficus elastica.*—The Indian rubber fig or caoutchouc tree, is indiginous to Assam, where it is found a dominant tree in the evergreen forests. It requires an exceedingly damp atmosphere, and the best natural rubber trees are met with in the forests at the foot of the hills, or on the hills themselves up to an elevation of Rs. 2,500 feet.

2. *Natural germination.*—In its natural state the rubber tree starts from seed dropped by birds in the forks of other trees, often 20 or 30 feet or even more from the ground, where it germinates, and the young plant remains an epiphyte for years until its aerial roots touch the ground; as soon as this takes place the little epiphyte changes rapidly into a vigorous tree, throwing out numerous aerial roots which gradually envelope the tree on which it first began life and often kills it out.

Having started life so high up it soon throws out branches which overtop the surrounding trees, and the numerous aerial roots which fall from these and establish connection with the ground, in a few years enable it to dominate the forest growth around it.

3. *Seed.*—The seed of this tree is contained in a fig shaped fruit, about 75 seeds being found in one good sound fig. The fruit first begins to form on the trees in March and ripens from May onward to December. On some trees the whole crop ripens and falls off by June, but as a rule the rubber tree has fruit on it from April right up to December, the figs forming, ripening and falling off the whole of the rains.

After collection the figs have to be carefully dried and mixed with pounded charcoal, which preserves the seed for several months.

4. *Seed beds.*—In the Charduar rubber plantation nursery, for a seed bed 40′ × 3½′, two to three seers of pulverized rubber seed, 10 seers ash and 20 seers of vegetable loam or good soil, are well mixed in a half cask and spread evenly over the bed, and then lightly stamped down and watered. Such a bed should yield with good germination, 2,000 seedlings and should be sufficient for putting out 100 acres of rubber planted 70′ × ′35. The beds must be well raised and drained, the soil being prepared in the same way as for vegetable or flower seed. If sown in boxes these should be put under the eaves of a house; if in beds light

removable shades must be put up to keep off the direct rays of the sun. The shades should be removed during rainy or cloudy weather and at night.

Light sandy loam is most suitable for seedbeds, if the soil is stiff, charcoal dust should be mixed with it to make porous and prevent caking. The beds or boxes must never be allowed to get dry.

5. *Sowing.*—This should be done exactly in the same way as for vegetable or flower seed which requires transplanting after germination. The figs are broken between the hands. As the seed is very minute the particles of the fruit are left with the seed and sown with it, no attempt being made to clean or separate the pulverized figs. In order to distribute these minute seeds evenly over the seed beds or boxes, a certain quantity of ash and soil is mixed with them.

6. *Germination.*—Germination takes place from the end of April to the end of rains. Seed sown between October and January requires daily watering and screening from the sun, and will not germinate before the end of April or the begining of May but seed sown any time during the rains will germinate in a few days (from five days to a fortnight). It follows the best time for sowing seed is during the rains that is from June to September.

The embryo appears on the germination of the seed as a seedling having a pair of opposite cotyledons with an entire margin destitute of incisions or appendage of any kind, with the exception of the notched or emarginate apex, oval in general outline, green in colour and of a glassy smoothness. The second pair of leaves shew a tendency to the alternate arrangement on the stem but appear at the same time. Their shape and venation are very different from those of the primary leaves for they have a central midril and a distinctly coarsely crenate margin. The third pair of leaves do not appear simultaneously, and are distinctly alternate with a marked reddish colour. After this the plant is easily recognized.

7. *Pricking out.*—When the seedlings are two inches high in the seedbeds *or boxes they should be transplanted into nursery* beds, and put out in lines about a foot from each other. The nursery beds should be well raised and drained but the soil need not be so carefully prepared as for the seed beds. Here the plants are kept till the following rains when they are dug up and taken to stockaded nurseries in the forests and put out 5' × 5' on raised well drained beds; where they remain for two years till they are required for planting operations.

8. *Forest Nurseries.*—Almost every animal will eat the young rubber plants, it is therefore impossible to plant out small seedlings in the forest owing to the destruction by wild elephants and game, unless each individual plant is carefully fenced in. As this is too costly and the rubber after it is 1-2 feet in height is very hardy and

can be transplanted with ordinary care, at any time of the year (the best time in Assam is between May and July), the seedlings are kept in stockaded nurseries in the forest where planting operations are to take place, and remain there till they are 10 or 12 feet high, that is about three years after germination, when they are dug out and the roots are cut back 18 inches right around the plant and planted on the mounds in the forests.

9. *Planting operations.*—In artificial planting it is found that the rubber grows best on mounds. Lines are cut through the forest 20 feet wide and 70 feet apart from centre to centre; in these lines 15 foot stakes are put up 35 feet apart. Round each stake a mound is thrown up 4 feet high. The base of the mound is about 10 feet in diameter and tapers to 4 feet on the top; on this mound the rubber tree is planted, care being taken that the roots are carefully spread out before they are covered up with earth. To prevent animals pulling the plant and wind blowing them down they are tied to the stakes.

10. *Cutting.*—The rubber tree can readily be propagated from cuttings, if only perfectly ripe young branches or shoots are used, but the tree raised from cuttings does not appear to throw out aerial roots, and as the future yield of the tree probably depends on its aerial root system it is questionable whether trees raised from cuttings ought to be used except where required only as shade givers, such as in an avenue. In the Chardaar rubber plantation propagation by cuttings was given up very early, that is about 1876, the plantation having been commenced in 1879. The best time to take cuttings is May and June.

11. *General.*—The rubber grows equally well on high land or low land, in forest land or grass land, so long as it is planted on a mound and its roots are not exposed to the sun. It is a surface feeder, but as soon as its roots appear above ground they must be covered with fresh earth until such time as the tree has formed sufficient leaf canopy to protect itself.

VI.—EXTRACTS, NOTES AND QUERIES.

Tan and Dye extracts from Ceriops Candolleana.

The Kew Bulletin for February and March, 1897, contains the following information in regard to Ceriops Candolleana, which is at present attracting a good deal of attention as a source of dyeing and tanning material.

Letter from Mr. H. N. Ridley, Director Gardens and Forest Department, Straits Settlement, to the Director Royal Gardens, Kew.

I am sending you a small box of extract of Tengah bark (*Ceriops Candolleana*). This bark is used here for tanning, and also for dyeing, especially in conjunction with Indigo. The bark was cut up in bits and boiled for two hours in a copper pan, and the liquid eventually dried by heat.

In dyeing, it is used to give a brownish red color to cloth, but especially to get good black and purple. The cloth is first dyed in Tengah, dried, and then dipped in Indigo, and comes out purple or black according to the strength used.

The tree is very common here and used as firewood, and the bark mostly wasted. So it could be prepared at no great cost. I should be glad if you would get an opinion on it it either as a dye or a tan.

Mangrove extracts have, I believe, been tried before, but have not been successful, because there has not been any attempt to discriminate between the species, but all kinds of barks have been stewed up together and the result tried. Now, I am going to work through all the Mangrove tan barks one by one, and try if we cannot make some use of them.

Note by Mr. J. J. Hammond, Professor of Dyeing, Yorkshire College, Leeds.

"Tengah" bark extract behaves as regards its dyeing properties in a similar manner to a good quality of Catechu.

When used along with Indigo, as is apparently the practice, the latter is probably applied in a "Copperas" (ferrous sulphate) vat; in which case the "Tengah" will combine with the iron and produce, as indicated above, a grey colour, which in conjunction with the Indigo blue gives the black.

Tengah extract would certainly be of value to dyers.

The Extraction of Gutta-percha from the leaves of the Isonandra Gutta-percha Tree.

Mr. Bourdillon has sent as a copy of an interesting report on the above subject by Professor W. Ramsay, Ph.D., F.R.S., of University College, London, from which we make the extracts given below. Could not a somewhat similar process be applied for extracting India rubber from the leaves of *Ficus elastica*? Perhaps some of our readers who are in charge of rubber forests would make experiments in this direction and let us know the results.

"The existence of a gum of a plastic nature in certain of the trees found in the Malayan Archipelago was first indicated by Montgomery, in 1832; but it was not until 1847 that Mr. Thomas Lobb sent specimens to Sir William Hocker. The material extracted from this tree was named "Gutta-percha"—or the "Rag Gum," to translate the word literally, The word "rag" refers

to the appearance of the gum before it has been kneaded into the usual compact form in which it is known in commerce. In 1848 the material was patented as an insulator for telegraphic wires by Messrs. W. H. Barlow and T. Forster, and in the following year by Dr. Siemens ; so that its value for the purpose for which it is now in ever-increasing demand was early recognised. In 1849 Mr. Walker Breit laid the first cable, two miles in length, in the English Channel. It consisted of wire, insulated with Gutta-percha ; and at the present date, with the exception of a small consumption for bottles and stop-cocks to resist the action of strong acids, almost all the Gutta-percha produced is used to cover the wires of submarine cables. But the supply is far behind the demand. There is in existence to-day no less than 162,000 nautical miles of cable, and in 1884 over 3,000 tons were exported to England, involving the destruction of 12,000,000 trees of thirty years old. Owing to this great destruction of trees, the quantity of Gutta-percha in the market has been greatly diminished, and the price has risen accordingly, while the material is no longer of such good quality as it used to be. Indeed, it is stated ("Le Caoutchouc et le Gatta-percha," by E. Chapel, Paris, 1892) that the Chinese merchants are so much in the habit of adulterating the pure gum with resins from other species of trees, that it is not possible to find a pure specimen of Gutta in the market. The gums from species of Euphorbia are frequently used for this fraudulent purpose."

"There is great need to increase the supply of genuine Gutta-percha; and there is every prospect that a rich reward would recompense a successful effort to do so."

"The present process of producing Gutta-percha is, as has already been indicated, wasteful in the extreme, and very costly. The trees are either ringed, so as to cause a flow of sap, or felled, and in either case the tree is destroyed. Moreover the gum is mixed with impurities of vegetable matter, such as pieces of bark, and even with mineral matter, like sand and earth; to say nothing of the adulterations fraudulently added by the Chinese merchants. This necessitates a costly purification, which is achieved by softening and kneading the gum, or by squeezing it through wire gauze or some similar process, the results of which are, at the best, not very satisfactory. Solution in bisulphide of carbon, or in benzine, has also been tried as a means of removing these impurities, but the quality is thereby deteriorated. After the impurities have been mechanically removed, the gum is rolled between grooved or spiral rollers to expel water and air."

"The yield from a single tree, too, is by no means great. A tree of fifteen to twenty years old gives only three to three and three quarter ozs. of Gutta, one of thirty years old gives some nine ozs., according to Serullas ; and Burck gives about ten ozs. as the yield of a dichopsis tree twenty-six years old."

"The juice as it flows from the tree is white, on standing, it solidifies spontaneously, forming a sort of pellicle on the surface. On boiling or heating the juice, the Gutta collects into a more or less coherent lump."

"The Gutta as it comes into the market has usually a brown colour, which, however, does not belong to the pure gum, but is due to a trace of colouring derived from the bark; in some specimens the colour is dirty-white or pinkish, but the pure gum is really colourless. After being kept in the air for some time, the gum changes spontaneously to a brittle resin; this change does not occur if light be excluded, nor is the gum changed by light if air be excluded. Under water it is quite stable, whether the water be fresh or salt. It is found, too, that specimens differ in their power of withstanding the action of the air, and it is believed that the purer the Gutta the better it will resist the action of the air. *It is found, indeed, that pure Gutta is only slightly attacked even after a very long exposure to light and air.*"

"In what is usually termed "Gutta-percha" three distinct chemical substances are to be found. On boiling the gum with absolute alcohol a quantity of resinous matter is dissolved, varying with the specimen of Gutta employed. Even the purest gum in the Market yields some 18 to 20 per cent. of its weight to boiling alcohol; and only what is left can be considered to be the chemically pure compound. Of worse varieties of gum, 40 or even 50 per cent. may be thus dissolved. These dissolved resins, although possessed of good insulating properties, cause the Gutta to deteriorate very rapidly if they are present in large amount; it becomes friable and easily disintegrated, owing to oxidation. It is their presence in poor qualities of Gutta which renders them unsuitable for telegraphic purposes. But up to 18 or 20 per cent, they do not appear to act injuriously. The resins are named "albane" and "fluavile" respectively; the former, when quite pure, forms white crystals, the latter is a yellow gum. Both appear to be products of oxidation of the pure Gutta, albane containing twice as much oxygen as fluavile. Oudemans gives the formula of albane as $C_{20}H_{22}O_2$, and that of fluavile as $C_{20}H_{22}O$. But the chemical nature of these bodies, including Gutta-percha, has hardly been explored."

"M. Serullas has been led to devise a method of extracting these mixed gums from the leaves, instead of from the trunk of the Isonandra Gutta-percha. This tree used formerly to flourish in the Malay Peninsula in the neighbourhood of Singapore, but until it was re-discovered in 1887 by M. Serullas, it had not been utilised as a source of Gutta for thirty years, and it was supposed to have become extinct. It is the product of this tree which M. Serullas says is best adapted for telegraphic purposes, for it yields gums containing the highest percentage of pure Gutta, mixed with the smallest proportion of albane and fluavile."

"In the best Gutta, the following are the proportions of these constituents :—

Pure Gutta-percha	...	75 to 82	per cent.
Albane ...	...	19 „ 14	„
Fluavile ...	...	6 „ 4	„

"The process of extracting Gutta-percha from the leaves is an exceedingly advantageous one. To quote from the *Sarawak Gazette*, of the month of April, 1895 :—" A tree of twenty-five to thirty years old yields one catty (one and one-third lbs.) of pure dry Gutta, the same amount can be obtained by two pluckings of the leaves." The *Gazette* goes on to say that the stumps of trees which have previously been felled have now become covered with shoots, bearing rich crops of leaves ; and that M. Hourant has induced the natives to collect these leaves, and that they are now exported in considerable quantity."

"M. Serullas states that a tree thirty years old yields 25 to 30 kilograms (55 to 66 lbs.) of green leaves, or about 11 kilograms of dried leaves (24 lbs.), from which it is possible to extract, by methods to be described, no less than 1,000 to 1,100 grams (over 2 lbs.) of Gutta-percha, while the felled tree yields only 365 grams as a maximum. It would thus require that a tree should yield only 7 kilograms of fresh leaves per annum in order to give as large a supply as the whole tree felled, and with much less expenditure of labour."

"It now remains to describe the method of extracting the Gutta-percha from the leaves. The process is due to M. Serullas.

"The leaves, either fresh or dry, contain Gutta-percha. The process of drying, whether artificial or natural makes no difference to the percentage of Gutta, if the latter be reckoned on the dry leaves. The leaves, after being dried, are ground to a fine power, and then mixed with one-tenth of their weight of caustic soda dissolved in water, and heated to boiling, or indeed digested under a slightly increase pressure. The liquor turns dark brown in colour, owing to the solution of a brown colouring matter, to which the Gutta-percha which usually comes into commerce owes its colour. The weight of the leaves, and also their bulk, is materially decreased by this process. The powder is then dried by heating to 212°F. ; a solvent is added, in a closed vessel, so as to hinder loss by evaporation. The mixture is heated so as to effect the solution of the Gutta-percha more quickly. The mixture is placed in a filter press, and the solvent is separated as completely as possible. The residue of leaves is washed with fresh solvent so as to extract the whole of the Gutta. The solution is of a greenish-brown colour, owing to the solvent dissolving out some chlorophyll—the colouring matter of leaves. As some solvent remains adhering to the powdered leaves, a current of steam is driven through this residue, which carries off the solvent and per-

mits of its recovery. The extract is next placed in a still, and the solvent is partly removed by distillation, the pressure being somewhat reduced, so as to cause its boil at a temperature lower than that of boiling water. The concentrated extract is then run into a tank and mixed with twice its bulk of a volatile liquid. On mixing this liquid, which is done in a closed tank, there is produced a flaky or "raggy" precipitate of Gutta-percha. This precipitate is filtered off again by means of a filter press and the mixed liquids are run into a retort where they are submitted to distillation and are thus separated."

"The cakes of Gutta-percha from the filter-press are dried at a low temperature; they are then heated so as to soften them, and in presence of water they are moulded into lumps."

"The process is thus seen to be a very simple one. The products are easily prepared, and there is no loss except the unavoidable one, which *always occurs when any substance is put* through a round, and which is unlikely to be considerable."

"The next question is as regards the yield of Gutta-percha from the leaves and twigs. The following table is extracted from the valuable work on "Caoutchouc and Gutta-percha," by Seeligmann, Lamy, Torrilhon, and Falconnet, published by Britach, of Paris, 1896:—

"Old dry wood	...	...	...	10	per cent.
"	...	...	...	9·15	"
'Dry twigs	...	...	...	10·20	"
"	...	...	...	10·50	"
'Dry leaves	...	...	...	10·02	"
" imperfectly dried	...		...	9·06	"
" imported in water	...		...	10·05	"
" " "	...		...	9·00	"

"I have myself extracted Gutta from the leaves of the tree, by the process of Serullas, some six or seven times. Even on a small scale, where the difficulties of extraction, filtration, &c., are much more considerable than on a larger, I have obtained a theoretical yield. The following is a typical analysis of a sample of leaves, chosen at random from among many:—"

Water in the naturally dried leaves ...	19·92	per cent.
Extractive matter removed by caustic soda	55·00	"
Gutta, reckoned on the thoroughly dried leaves	9·61	"

"The statements made by M. Serullas are therefore thoroughly borne out."

The following letter from the Director, Gardens and Forest Department, Straits Settlement, to the Director, Royal Gardens, Kew, which is printed in the Kew Bulletin for May and June 1897, gives a somewhat different account of the process. "I have just been to inspect the little factory where Mr. Arnaud makes his gutta-percha. Serullas has gone back to Paris with endless patents of different kinds, and Mr. Arnaud alone keeps up the

business. The leaves are imported in sacks dry, from Borneo and Johore. Most of the trees are overcut in Singapore, and there are no more leaves left, I hear. The leaves and twigs cost four dollars and half a picul (133 lbs). They are then put, damped with hot water, into a rolling machine, two rollers working against each other, which grind them to powder. The powder is thrown into tanks of water and shaken about. The gutta floats in the form of a green mealy-looking stuff, is lifted out by fine copper gauze nets, put in warm water and pressed into moulds. I have samples of the gutta as it comes from the leaves, and the pressed out finished article. It is really a very curious little manufactory. I do not know how long it will last, on account of the difficulty of procuring leaves, which must, I think, sooner or later stop the trade."

Siamese Forests.

In the course of Mr. Beckett's report on the trade of Chiengmai he says :—The whole question of forest leases and of forest conservancy has been closely studied during the year by a Conservator of Forests lent by the Government of Burma. In view of the fact that nearly three-fourths of the teak timber industry is worked by British capital,, the objects aimed at by the Conservator and the measures already taken are worthy of special notice. His objects briefly are these—(1) to limit the areas worked; (2) to increase the girth and therefore the age at which teak trees may be felled, and to prohibit the indiscriminate felling of trees less than 4 soks (6 feet 6 inches) in girth at the base; (3) to avoid depletion in the near future and provide for a sustained annual yield by dividing the whole teak-bearing area into a fixed number of sub-areas, each to be worked over at fixed intervals of time; (4) to secure a fixed revenue to the owners of the forests and the Government of Siam by the payment of royalty in the case of the Salween forests at Moulmain and of the Menam-floated timber at Chainat. The revenue derived hitherto from this source has, owing to the irregular collection of royalty by local administration proved but a fraction of the total due; (5) to forbid the working of any forest without a lease and to refuse the grant of any further leases, and in such leases as have been given to exchange the old for a new form embodying the objects above-mentioned and introducing other special conservancy clauses.

Amongst the more important measures taken are the introduction of a new lease and of the new arrangement as to payment of royalty. Seven leases only were given in the old form adopted

at the end of the year 1895, the first lease being dated the 7th December, 1895, and the last the 29th July, 1896. The point of resemblance between the old and new leases are—(1) all leases are to be for a term of six years; (2) royalty is at the rate of Rs. 4 for a log for Menam-floated timber, and Rs. 8 for Salween timber; (3) registration of property hammer-marks at the usual fee; (4) lease liable to cancellation by a competent Court for any breach of its conditions.

The most important feature of the new lease is the division of the lease into two parts; the first containing four clauses signed by the owner of the forest and the lessee, and the second 15 clauses containing the conditions regulating the conservancy of the forest leased, on which the Government of Siam by the Siamese High Commissioner agree to recognize and ratify the lease.

In the first part are the following new provisions:—(1) No conversion of timber until royalty has been paid. (2) Extension of period of lease, if necessary, for removal of timber unextracted and lying in the streams. (3) No girdling of teak during 12 months immediately preceding the termination of the lease.

In the second part the most important new restrictions are—(1) Increase of girth from 6 kam (25½ inches) to 9 kam (38¼ inches). (2) Teak trees to be girdled at least two years before felling; (3) No teak tree to be girdled unless there is another teak tree in the vicinity able to cast its seeds on the ground covered by the tree to be felled; (4) A fine for each tree so damaged in felling as to be not worth extracting or at lessee's option payment of royalty and duty. (5) A fine for each teak tree consumed or damaged by fire before reaching Paknampho. (6) Permit-holder and lessee to be jointly responsible for all fines and penalties inflicted under the lease. (7) The Minister of the Interior to have the right of closing the forest or any part of it for sylvicultural purposes. (8) Option of the Forest Officer to claim all rejected logs on repayment of royalty paid by lessee on such logs.

These new conditions have been accepted *in toto* by the two large British teak-trading companies and their example is being followed, though somewhat tentatively, by the Burmese and Shan foresters. The conditions are generally approved of as removing numerous vexatious clauses as to the registration of elephants, overseers, &c., but I have received complaints from the foresters and contractors as to the hardship to them, of the terms, as to the fine for damage in felling, the right to close the forest at any time for sylvicultural purposes, and the option of the Forest Officer to claim rejected logs. They would also prefer to have the extension of time for removal of logs fixed in all cases to 24 months and not be left to the discretion of the Conservator of Forests.

These few clauses are doubtless hard upon foresters, but since the object of the new lease is to render the extraction of teak more difficult, the insertion of these clauses can hardly be called a real

grievance. The effect of the new lease will be to throw the timber industry more and more directly into the hands of the companies with large capital and out of the hands of the Burmese foresters.

For the coming six years at least British traders may rely on an undiminished output. After that period there may be falling off in supply owing to the more restricted areas and more stringent regulations. But with considerable forest-areas in the provinces of Nan and Phre still scarcely touched, except in an irregular manner under a system of permits given by the local chiefs, and with the prospect of a further yield in future from forests now to be secured against entire depletion, the British merchant need not have cause for alarm.

There was no increase in wages of Khamus until the end of the year when they rose from Rs. 50 for the first and Rs. 60 for the second year's engagement for each Khamu to Rs. 70 and Rs. 80 or even Rs. 90 which was still further raised, Rs. 5 owing to the establishment at the commencement of 1897 by the French agent, of a fee of that amount per man per annum. The supply is irregular and inadequate for forest requirements. On a rough calculation there are some 4,000 Khamus now engaged in timber work. These men stay only two years in Siam and then return perhaps for a year or longer to their homes in Luang Prabang province. They come inexperienced in the difficult craft of felling teak timber, and if trees are not to be damaged in felling, as stipulated in the new forest lease, some other source of labour will have to be discovered.—*Rangoon Gazette.*

The Forest School Athletic Sports.

The Annual Fixture was brought off on Friday and Saturday, the 15th and 16th October, and was graced by all the beauty and aristocracy of Dehra, European and Native, besides a good deal that was apparently neither beautiful nor aristocratic. The absence of nearly all our Garrison, the 2nd P. W. O. Gurkhas, on service was much regretted.

The first day was devoted to first heats, but there were only two races, and the long jump, in which the entries were numerous enough to necessitate the process of elimination, so the cricket ball was decided outright, thus leaving a comfortable programme for the next day. This event was won, as last year, by R. R. Fouracres, with a throw of 279 feet, the native's prize being taken by Narasappaya, with 250 feet.

The 100 yards flat race for native students was run in two heats. The first was won by Govind Rao Sapre, in 12 $\frac{3}{5}$ secs. with Mulraj in attendance. The second heat went to Govinda Menon, in 11 $\frac{4}{5}$ secs. followed by Mahanand. These four were thus left in for the final.

The hurdle race, 120 yards, open to the whole school, was also run in two heats. The first was won by D. A. Allan, in 18 secs., with C. A. Clerk next. The second heat went to Fouracres in $18\frac{3}{5}$ secs. with Purkis next. These four were consequently left in the final. This first day was ended, and the second well (or ill) begun by a dance very generously and kindly got up by some of the residents of the station, for the special benefit (?) of the students.

The second day's proceedings began with a flat race, 100 yards for native students. It was won by Govinda Menon, with Govindrao Sapre second in $11\frac{4}{5}$ secs. The next event was the long jump, in which J. Brown cleared 18 feet 11 inches, and Fouracres 17 feet $5\frac{1}{2}$ inches. Govinda Menon was the best of the natives, taking the prize with less than his first heat leap of 15 feet $9\frac{1}{2}$ inches. Mul Raj only did 13 feet 9 inches, but would do a great deal better with practice.

The next event was the open flat race, 100 yards. It was won by R. R. Fouracres in $10\frac{4}{5}$ secs., G. F. Matthews being about a yard behind. The hurdle race for native students, 120 yards, over 10 flights, gave rise to some excitement, and was won by Govinda Menon in 22 secs., with Mul Raj close up. The high jump was then brought off, the best being F. Edwards, with 4 feet 10 in. The prize for natives was taken by Govinda Menon, who jumped in fine style and was not far behind. The next event was one in which a good deal of interest was taken, namely, the open hurdles, and it produced a first rate competition. The winner was D. A. Allan, in $17\frac{1}{5}$ secs., with Fouracres and Purkis well up. The win was a very popular one, for the junior class which Allan represents, has but few Europeans to emulate the records set by their seniors, and maintain the School's reputation in the branch of sports. A flat race, 100 yards, for school and forest servants was won in excellent time by an outsider who slipped himself in among the competitors and was duly disqualified after setting the race in high class style. The half mile was the last of the races proper, and was not the procession that these long races often are. It was won by F. C. Purkis in 2 min. 25 secs., Fouracres taking second prize. The final events was the tug-of war, seniors *v.* juniors. The latter made a gallant struggle, but were nevertheless pulled over twice. The prizes were then distributed by Mrs. Gradon, each recipient being heartily cheered. In the unavoidable absence of the Director on duty, the Deputy-Director in very few words, thanked Mrs. Gradon for distributing the prizes and the visitors for having so greatly contributed by their presence to the pleasure and success of the meeting, which then closed by the students giving hearty cheers for Mrs. Gradon, the visitors, staff, &c. The usual arrangements were made to keep the ground by a detachment of Police, but nothing less than a 10 foot wall would convince a Dehra crowd that there was any place closed to it.

A Menace of Treelessness.

Generally speaking, says a writer in the "New York Tribune," the growth of American industries is cause for satisfaction. To be able to say that exports of some leading commodity are now 25 per cent. greater than a year ago, and 100 per cent. greater than ten years ago is highly gratifying. Yet exceptions to the rule are quite conceivable. If it should appear that the growth of trade in any important product was tending to exhaustion of native resources and consequent domestic embarrassment and disaster, the circumstances would give rise to apprehension rather than pleasure, and economical wisdom would suggest the direction of efforts toward the restriction of that industry or toward such modification of it as would avoid the evil results threatened. That is the case at present with the lumber trade. It is a legitimate and important industry, and one that should be so cherished as to insure its profitable permanency. But it is now growing at a rate which threatens in the near future its own self-exhaustion and the reduction of this country to the deplorable and ruinous state of treelessness. The facts cannot be concealed and should not be ignored. Throughout all the older States of the Union forests have long since practically disappeared. Only a few straggling and stunted remnants remain of the superb sylvan growth that once clothed every hillside. The effect is apparent. Streams that once flowed constantly the year around, are now overflowing torrents for a few weeks and dry for months. Springs have dried up. Soil has become arid and sterile. Droughts are more frequent. Agriculture is less profitable. The evils that afflict the treeless countries of the Old World are beginning to be felt. Nor are the newer States of the Far West exempt. Their abundant forests are disappearing like snow in springtime, and in their place are coming changes of climate, disturbances to the water supply and the whole train of evils that forest-destruction inevitably entails.

It is idle to point to the vast expanses of untouched woodland that still remain, and boast that they are inexhaustible. They are not inexhaustible. On the contrary, the time when they will all have been destroyed is now within measurable distance. It is easily within the lifetime of men now living. This year, as already stated, our exports of lumber are about 25 per cent. greater than last year, and 100 per cent. greater than ten years ago. Even at the present rate of cutting, the forests would not last long. But at such an increasing rate their disappearance is startlingly close at hand. Nor is that all. The figures cited are only those of exports. Domestic consumption is increasing still more rapidly. The single item of wood-pulp for paper manufacture means an

enormous destruction of timber never dreamed of a generation ago. The lumber industry cannot, of course, be abolished. Tree-cutting must continue. But it is high time such regulations were adopted and rigidly enforced as will prevent the utter destruction of forests. This is entirely possible. Not the mere amount of lumber cut, but the amount destroyed, wasted by careless and injudicious methods, is what most counts. Every one who has visited a great lumber camp knows that more material is destroyed than is sent to market. The smaller trees, not large enough for marketable timber, are regarded as mere incumbrances, to be slashed and burned and got out of the way in whatever fashion may be readiest. The ground is thus entirely cleared. The great beds of moss and leaf mould, hitherto perennial reserves of moisture, are dried up. The soil and rocks are exposed, and the country transformed into a desert. What should be done is evident. The small trees should be carefully preserved, so that they may in turn grow to full size, and meantime shade the ground and preserve the forest conditions. Lumbering should, in brief, mean a judicious thinning out, not a wholesale destruction, of the forest. Tree planting should also be practised on an extensive scale, forest fires be more scrupulously guarded against, and the woodland area of the country be systematically cultivated, instead of ruthlessly raided. Other nations neglected the lesson long, but have learned it at last, and now enforce it with a strictness that here might seem despotic. But this nation is bound to come, sooner or later, to some such system of forest conservation, and it will be fortunate if it does not reach it through the ruinous experience of treelessness.

Kino from Myristica malabarica.

An astringent, red, resinous substance obtained from the sap of various trees of tropical countries is known as Kino. The best medicinal kind which contains 75 per cent of tannic acid comes from the Indian Kino tree *Pterocarpus Marsupium*, Roxb, while Bengal Kino is obtained in the form of round tears of an intense ruby colour from *Butea frondosa*. Kino is usually used in medicine for its astringent properties in cases of diarrhœa, chronic dysentry, &c.

Among the various specimens obtained for the museum of the Royal Gardens from the International Forestry Exhibition held in Edinburgh in 1884, was a peculiar dark resinous substance labelled " Kat jadikai " or Kino obtained from *Myristica malabrica*. It formed part of a collection of products made by Mr. Rhodes Morgan, District Forest Officer, Malabar.

In appearance the substance is very much like that obtained from *Pterocarpus Marsupium*. It has since been examined by Professor Edward Schaer, of Strasburg, who has communicated an interesting account of it to the Pharmaceutical Journal (4th series Vol. III. p. 117), from which the following extracts are taken :—

" Professor Warburg, of Berlin, has kindly forwarded to me a sample of an extract or secretion resembling official Kino which with well known liberality had been put at his disposal by the Director of the Royal Gardens, Kew. The sample in question is labelled Kat jadikai, that is to say cutch like product of jadkai (Tamil name for *Myristica*), and known to be produced by incisions in the bark of *Myristica malabarica*, Lam., in Southern India, showed in its exterior appearance more direct analogy to the well known Malabar Kino than to the ' Kats ' of *Acacia* (Cutch) or of *Uncaria* (Gambier). It consisted like official Kino of smaller or larger angular transparent pieces of deep garnet colour in thin fragments. It was not altogether unlike small broken dragon's blood in some respects, and the latter name has been used sometimes by natives and merchants for some kind of Kino (from *Pterocarpus indicus* and *P. erinaceus*).

" Not having been acquainted before that time with kino-like products from the genus *Myristica*, and following the suggestion of Professor Warburg, who was then preparing a monograph of the Myristicaceœ, I at once proceeded to a closer examination of the new substance, availing myself of the latest observations concerning the natural history of the different kinds of Kino, especially of the drug derived from *Pterocarpus Marsupium* (Malabar Kino). Not only on its external appearance but also in its behaviour to water and other solvents, the ' Kat Jadikai ' or kino from *Myristica malabarica* agreed almost entirely with *Ptercarpus* kino, giving a reddish, slightly turbid solution of feebly but perceptibly acid reaction to itmus paper. The other physical qualities, for the most part proved to be the same as those described by Hanbury and Fluckiger (*Pharmacographia* II. Ed. 1879, p. 195.) The same may also may be stated concering the more important and characteristic chemical reactions when compared with the chemical behaviour of official kino."

Professor Schaer thus summarises the result of his investigations into this and some other kinds, the produce of species of Myristica.

I. The dried juices of the bark of several Asiatic species of *Myristica*, for instance *M. malabarica* Lam., and *M. fragrans*, Houtt., as regards their appearance and physical qualities, show but little difference from the official Malabar Kino.

II. These substances, which may be termed Myristica Kinos, agree in the chemical reactions due to their contituents, in all important points, with the Kino of *Pterocarpus Marsupium*. It can therefore be stated that drugs of a very similar character,

and partly of close resemblance to official Kino, are to be found in the families of Leguminosæ (*Butea*, *Pterocarpus*, *Millettia*), Saxifragaceæ (*Ceratopetalum*), Myrtaceæ (*Eucalyptus*, *Angophora*), and Myristicaceæ.

III. The *Myristica* Kino differs, as far as can be observed from the *Pterocarpus* Kino, and probably also from *Butea* and *Eucalyptus* Kino, by containing, in the crude state of the inspissated fresh juice, smaller or larger amounts of a distinctly crystalline calcium salt, *viz.*, calcium tartrate, suspended in, and depositing from, the liquid juice. By this characteristic admixture it can be easily distinguished from the official Kino, and probably also from other Kinos of commerce.

Whether this new substance might ever be obtained in combination with the production of nutmegs and mace, so as to play the part ef a commercial drug, will depend upon a still better knowledge of its qualities, its formation in the living plant, its quantitive relations and similar questions.

KEW BULLETIN.

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Nitrogen and Forest Crops. *

Forest trees are little behind agricultural crops in their demand for nitrogen. This element, in association with carbon and water, forms the varied and important group of proteids, comprising, among other things, the fundamental basis of every living cell, namely, protoplasm. Accepting the figures of the Bavarian foresters, a beech forest, for instance, may produce annually 3,000 kilogrammes of wood and 3,000 kilogrammes of leaves, dried at 100°C. The 3,000 kilos of wood contain 15 to 25 kilos of nitrogen, since this element constitutes from 5 per cent. to 8 per cent., of the whole. The leaves also, when they fall, will contain 30 kilos of nitrogen or thereabouts, hence, unless the nutrition and consequent production of the forest are to diminish, some 45 to 55 kilos of ni trogen, per hectare, must be forthcoming to make up the loss. In agriculture, there is an essential difference, in that field crops have in general a greater need for nitrogen, and return little or nothing to the soil, while the forest, at the close of each growing season, returns to the soil,in the form of dead leaves, the greater part of what it has borrowed. Field crops leave behind little beyond their roots, and in the case of turnips, beet, &c., not even this. Hence the necessity of applying green manures, stable litter, nitrates, ammonia salts, &c, to obtain a continued fertility. Soils like the black earth of Russia, which need no manure, are extremely rare. A forest is never manured, but in spite of the continual loss of nitrogen by decomposition and by the removal of wood, vegetation flourishes indefinitely, and the soil becomes even richer in nitrogen, as is seen in the re-clothing of bare areas. What then are the causes which bring about a gain instead of a loss ? The question of manures has raised the most lively and still undecided controversies in agriculture, but forests are on a somewhat different footing, and require separate consideration.

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* 1. Translated by F. Gleadow from an article by E. Henry, in the "Revue des Eaux et Forêts.'

Gains. The forest soil may gain nitrogen :—

1. *By the plants or soil* abstracting it from the air or from rain, &c.

2. By deriving it from matters returned to the soil by plants or animals.

3. By the fixation of gaseous nitrogen, either by living plants, or by dead organic matters, or by the soil.

There seem to be no other possible causes of increase in the quantity of combined nitrogen.

Losses. The soil loses nitrogen:—

1. By the removal of the plants or wood produced. As already stated, this consumption is about 50 kilos of nitrogen per hectare, per year, of which about 20 *kilos* are removed *as wood* and do not return to the soil.

2. By the amonnt of combined nitrogen carried off in drainage water.

3. By the amount of combined nitrogen which decomposes and returns to the air in the gaseous state.

There seem no other possible causes of loss. On balancing these two accounts, it will be seen whether the soil has become richer or poorer in this important but scarce constituent. Chemical analyses made at sufficient intervals will be of great assistance. Let us examine first the losses. These are caused principally by the removal of wood. Of the two other causes, the loss by drainage waters does not occur in forests because of the absence of nitrification in forest soils. It is only nitrates that are carried off in drainage water. It is in fallows and in fields, especially after manuring, that the loss by this cause is greatest.

In 1895, M. Dehérain found, in the water drained from four plots, from 110 to 130 grammes of nitrogen in the nitric state, per cubic metre. From these figures, combined with those representing the variable quantities of water drained off, more or less as the soil had been more or less worked, he concluded that 84 to 144 kilogrammes of nitrogen per hectare were carried off by drainage. Nothing of the sort happens in the forest, where I have satisfied myself that even on limestone soils there is no nitrification.

On the 20th May, 1897, I took 10 samples of soil from neighbouring spots, some in forest, others in the open. Of each, 30 grammes were triturated in 25 cubic centimetres of distilled water. After a day's maceration, one or two drops of the solution, let fall into 4 drops of sulphate of diphenylamine, will produce a blue cloud if there is but a trace of nitrates. This reaction is extremely sensitive. If one centigramme of nitrate of potass be dissolved in a litre of water, a single drop of the solution let fall into the 4 drops of diphenylamine produces almost immediatly a bright blue cloud.

Three samples of soil taken from a bare place in the Bellefontaine nursery, not having been manured for two years gave

the reaction distinctly. Two samples, taken 50 yards off, in the forest, under a high polecrop of beech, showed no sign of nitrates. A sample taken inside the nursery itself, soil covered with matted grass, &c, but sheltered by an old beech, gave no sign, neither did two samples, taken from the woods of M. Hinzelin. On the other hand, two samples, one taken from a fresh ploughed field below the nursery, the other from near Maxéville, gave distinct indications. Boussingault, during his fine study of nitrification, long ago remarked the want of nitrates in the forest soils of Alsace. Ebermayer also, the eminent Munich Professor, in 1888 published an important paper "on the nitrates in forest soils and trees." "The examination of more than 100 samples of soil, from 'as many different spots, mostly in the mountains of Bavaria, 'showed that forest and peaty soils are nearly or entirely free from 'nitrates, while field and garden soils, manured with night soil, 'stable litter, liquid manure, &c, are all rich in this valuable 'plant food. Even the black earth, which is sometimes found in 'considerable thickness in certain forests of the Bavarian Alps, is 'almost entirely free from it. Thus, according to Ebermayer, the 'microbe of nitrification is not found in forest soils or peats. 'In other words, in all soils whose humus is of exclusively 'vegetable origin the general conditions are quite opposed to 'nitrification, and the decomposition of the nitrogenous principles 'of vegetable matter seems limited to the formation of ammonia—" '(Grandeau.)

M. Bréal also has reported that there are no nitrates in the soil either of forests or of meadows. As nitrification requires the presence in the soil of alkaline substances, the absence of the nitric ferment might be due to the want of lime or to the acidity of the forest soils examined. Therefore I thought it desirable to repeat the experiment in the Forêt de Haye, where the surface soil is very thin, rests immediately on limestone, and has but a poor covering of dead leaves. If nitrification is not found in such a forest, it is found in none. The first trials were negative, but too few to be final. I shall therefore take up the question again at the end of the summer, when the season is most favourable to the progress of nitrification.

If nitrates are not formed in forest soils, it may perhaps be due to the presence of other ferments which reduce the nitrates as soon as they begin to form. M. M. Gayon and Dupetit, Dehérain and Maquenne, have proved that, in a reducing atmosphere, the decomposition of nitrates is brought about by microscopic organisms, which they have called *Bacillus denitrificans* because they act in a sense contrary to the *Bacillus nitrificans*, which produces nitrification. M. Bréal has shown that these denitrifying organisms, which exist in straw, and doubtless in all vegetable *débris*, decompose nitrates, partly by forming organic compounds, and partly into gas which is dissipated in the air. M. Bréal says that

"in the soil of permanent meadows and of forests, where there is so much dead vegetable matter, this aerobic nitrate-reducing ferment must be plentiful and an obstacle to all nitrification." Further, all experimenters agree that in nitrification, that is to say, in the transformation of ammoniacal salts or of primary amines into nitrates, there is a constant evolution of gaseous nitrogen if oxygen is in excess. Thus whether, there is nitrification or not, a part of the combined nitrogen, the exact amount not being easily determined, disappears as gas, without profit to the crop.

The causes of loss then are two. One, which is considerable, amounting to a score of kilos, results from the removal of the crop. The other, less important, but uncertain in quantity, is the disappearance into the atmosphere of some of the nitrogen which in its various tranformations attains the gaseous state.

We now come to the causes of gain. The first is the combined nitrogen brought to the plants or soil by the air or by rain, snow, dew, fog, &c. Liebig, Boussingault, and others have shown that these natural elements contain ammonia and nitric acid. Boussingault found in rain from 0·11 to 3·49 milligrammes of ammonia per litre. In 1853, the mean was 0·42 mg. of ammonia, and 0·18 mg. of nitric acid. Fog contained, when condensed to a liquid, from 2·56 to 49·1 mg. of ammonia per litre. At six German stations, the amount of combined nitrogen in rain varied between 0·29 and 13 mg. per litre. The quantity varies with the locality and the year. Messrs Lawes, Gilbert, and Way estimated the combined nitrogen received per hectare at 8 kilos per annum. At Proskau, the amount was 23 kilos, at Regenwalde 17, at Insterbourg 6·2, at Kuschen 2·1. These quantities, though varying widely, are always small. There is also in the air a very small amount of carbonate of ammonia, which can be absorbed by the leaves or by the soil, as shown by Sachs, Schloesing, Mayer, and Muntz. Schloesing found, as a general mean for a whole year, 2·25 mg. of ammonia in 100 cubic metres of air, Muntz found the same. His experiments, begun in 1886 and ended in 1895, show that vegetable juices, whether acid or alkaline, absorb ammonia with as great avidity as a 2 per cent. solution of sulphuric acid does up to saturation point. Living leaves have only 3 to 5 per cent. of the absorptive power possessed by vegetable liquids, and M. Muntz draws the conclusion "that agriculture 'cannot expect any great assistance from atmospheric ammonia. 'Some, indeed, is received, but no more than is derived from the 'ammonia and nitric acid absorbed from the air by rain. We 'shall not be far from the truth in estimating the sum total of 'these sources at 5 to 6 kilos per hectare." It is certain that though the ammonia brought down by rain is not appropriated by the leaves, it is none the less absorbed by the soil, equally with potass and phosphoric acid, not an atom is lost. In the case of nitrates, we cannot be so certain. Nevertheless, seeing the

scarcity of these salts in forests, and the avidity with which plants take them up, it is probable that the whole is utilised. The absorptive power of the soil for ammonia is such that it takes up not only what is brought by rain, but also that contained in the air, derived principally, according to M. Schloesing, from marine evaporation. M. Schloesing's ingenious ideas on the circulation of combined nitrogen over the surface of the earth are well known. M. Schloesing's experiments on dry and moist earths, with and without lime, have shown that the soil takes ammonia from the air, and yields none to it. Dry earth, incapable of nitrification, naturally absorbs less ammonia than moist earth, in which, during the summer, nitrification is incessant; in the latter, the ammonia is continually transformed into nitrates; the tension is never in equilibrium, and the earth is always ready to absorb alkalies from the air to an indefinite extent. Consequently, the absorption is only limited by the rapidity of nitrification.

In a month and a half, from the 1st August to the 15th September 1875, two lots of fine dry earth not favorable to nitrification, exposed to the air, but sheltered from rain, increased their percentage, the soil with lime from 0·747 mg. to 2·504, the soil without lime from 0·219 to 4·145 mg. The absorption is necessarily limited by the equilibrium of tension in this case, but it is otherwise with a moist soil, favorable to nitrification. M. Schloesing found that the hectare in 14 days took up 2·590 kilos, and again in 18 days 4·097 kgm. or for the first soil at the rate of 63 kgm.and for the second 53 kgm., per annum. But as nitrification only goes on in summer, these figures must probably be reduced to half. But we need not concern ourselves much with this point, since we have seen that there is no nitrification in forests. Even when moist, and in the height of summer, forest soils always behave like dry bare soils, so that in forests we have only from 5 or 6 kilos (Muntz) to 10 or 15 kilos (Berthelot) received per hectare, whether through direct absorption of gaseous ammonia, or through rain, &c. This quantity is quite insufficient to make good the 20 kilos of nitrogen removed in the wood, and the loss through the return to the gaseous state of part, of the combined nitrogen in the soil. If there were no other sources to make good the loss, the forest soil would become continually poorer, which is not the case. There must then be other sources. Before it had been ascertained that certain plants have the power of fixing atmospheric nitrogen in their tissues, it was held, according to M. Schloesing, that the above difference of loss and gain was made good by the continual supply of ammonia brought, for France, principally by west winds. This was the commonly received theory until Hellriegel and Wilfarth showed conclusively that leguminous plants possess nodules infested by bacteria, which fix atmospheric nitrogen, thus proving the accuracy of the ideas enounced by G. Ville and by Berthelot, but disputed by most until 1888.

The second cause of gain consists in the nitrogenous matters annually returned to the soil in the form of vegetable and animal refuse. But this is not a true gain, since these matters belonged originally to the soil to which they do but return. It is merely a *restitution, and partial at that, since some is lost by becoming* gaseous in the process, and much more is lost with the wood removed. The forest can only be supposed to become richer in nitrogen by assuming that the quantities obtained from the air and from rain are greater than those lost in the wood and by dissipation into the air, an assumption which no degree of optimism can warrant.

There is, however, a possible third cause of gain. If the soil or the plants could draw from the atmosphere direct some of its free nitrogen (which is four-fifths of the whole) without its having *to be first combined with hydrogen or oxygen, there would no longer* be just grounds to fear that one day the available supply of nitrogen will become insufficient for plant life, and consequently for the continuance of animal life on the earth. On the contrary an inexhaustible reservoir of nourishment would be available. It is well known that animals can fix directly in their bodies neither the atmospheric nitrogen, nor ammonia, nor nitric acid ; they obtain all their nitrogen from the proteid matters of plants. Up to 1888 it was supposed that plants could indeed assimilate the two latter, but not the former. The principal advances since 1838 are as follows:—

1838—Boussingault's experiments began. He found a slight gain of nitrogen in clover and peas, none in wheat or oats. Without forming a decided conclusion, he is inclined to think that leguminous plants can fix nitrogen from the air.

1849-1852. M. George Ville made experiments, and stated that plants can assimilate gaseous nitrogen.

1851-1853. Boussingault made a second most careful set of experiments and concluded that gaseous nitrogen was not fixed by plants, not even by leguminous plants (lupins, haricot beans).

1861. Lawes, Gilbert, and Pugh, at Rothampstead, in order to test these contradictory statements, made experiments lasting 3 years. They took the most minute precautions, and their results confirmed those of Boussingault.

In 1879 it seemed that M. Grandeau was fully entitled to say "The matter is settled, plants do not absorb free nitrogen."

Nevertheless the prudent conclusions of the English chemists were less decided in the case of leguminous plants than in that of the gramineous class. In 1861 they wrote "after many trials 'with gramineous plants, and after varying the conditions of 'growth very widely, no assimilation of free nitrogen has been 'recognised. In the case of leguminous plants, the growth was 'less satisfactory, and the limits of variation were less, but the 'registered results show no assimilation of free nitrogen. ***Fresh***

'*experiments with these plants, in more favorable circumstances, are* '*desirable.*"

To Hellriegel and his co-workers was reserved the honor of executing these desirable experiments, of carrying them out in a manner that left no room for doubt or controversy, and of clearing up at last an obscure and difficult question which had been ardently worked at and discussed by chemists and agriculturists since the days of Priestely, Ingenhoutz, and de Saussure, a hundred years ago. The paper of Hellriegel, Wilfarth, and their collaborators dates from November 1888, though the principal conclusions had been announced in 1887. In the meantime there appeared some few researches on the fixation of nitrogen by the soil and by plants, of which the principal are the following.

1873. M. Dehérain published experiments showing that atmospheric nitrogen can combine with certain ternary substances, cellulose, glucose, &c., and as a corollary, with the decomposing matters in the soil. But M. Schloesing showed causes of error in these experiments, repeated them more carefully, and *found no fixation* of nitrogen.

1875. M. Berthelot asserted that certain non-nitrogenous organic substances, cellulose, benzine, turpentine, &c, with the aid of electricity, can fix the nitrogen of the air.

1885. Ten years later, M. Berthelot found a new and more general type of fixation of gaseous nitrogen, namely, the slow but incessant action of clay soils and of the microscopic organisims found in them.

1886. In a second paper he discussed *the nature and proportions of the* organic matter contained in these soils, matter which is the fundamental basis of the whole edifice formed by these nitrogen-fixing micro-organisms.

M. Berthelot next studied the fixation of nitrogen, not merely in sandy clays and kaolins, but in the vegetable mould itself; and in a later memoir, its fixation in vegetable mould by the aid of plants. "In fine" he says, "there was fixation of nitrogen in 'considerable quantities.

'1. In sands and clays, as well as in mould, without *vegetation ;*

'2. *In* the combination of plant and soil, when vegetation was introduced."

Thus, when Hellriegel's memoir appeared, it was already known through the work of Berthelot that soils with their contained micro-organisms can fix atmospheric nitrogen ; but none of these micro-organisms were known, none had been isolated and seen ; nothing was known of their mode of action, neither did their hypothetical presence in the soil explain the remarkable aptitude possessed by leguminous plants for prospering *in a soil free from combined* nitrogen, and for hoarding up in their tissues considerable quantities of a substance which could not be shown to exist in the soil.

For a long time botanists had been aware of the existence of nodules on leguminous roots. Woronine, in 1866, was the first to draw attention to innumerable corpuscles of their protoplasm, much resembling protococci and bacilli, and he considered them as microbes living in a symbiotic union with the plants, and manufacturing food for the benefit of the firm. But nobody thought of any relation between the radical tubercles and the fixation of nitrogen. The great credit of Hellriegel lies in the clear and decisive discovery of this relation. His memoir marks an important date in agronomic science, and its principal conclusions are as follows :—

"The assimilation and production of cereals, barley, and oats, 'were almost uniformly nil in a soil without nitrogen, whether 'sterilised or not.

'By addition of nitrates, these plants underwent a normal 'development, more or less directly proportionate to the quantity 'of added nitrates. (90 to 100 of dry soil to 1 of nitrogen.)

'Nothing tended to show that these plants obtain, or might 'obtain, any appreciable quantity of nitrogen from other sources 'for their nutrition.

'The leguminous plants tried, peas, serradelles, lupins, behaved 'exactly like the cereals in a sterilised medium, that is to say, their 'growth and assimilation were practically nil.

'This is the same result as Boussingault obtained in 1853.

'Nitrates produced the same effect on them as on cereals whenever nitrogen was present in very small proportions.

'In a soil without nitrogen, leguminous growth was sure to be 'obtained by adding a slight mixture of fertile soil. Not only was 'normal vegetation obtained, but often even a luxuriant develop-'ment, and in this case, the crop often showed a great excess of 'nitrogen which could not possibly have come from the soil."

The necessary conclusion was, that the small portion of fertile soil added had contained the germs of bacteria which attached themselves to the roots, produced nodules there, and set up a process of transferring gaseous nitrogen from the air into a combination with the substances of the plant. These facts have now been thoroughly verified, and as M. Dehérain says, "agricultural 'practice has taken advantage of them ; it has, by means of a 'dressing of fertile earth, succeeded in making leguminous crops 'grow on soils that had hitherto been refractory." Quite recently, M. Mazé has shown that leguminous plants have to furnish to the nodular microbes the organic nitrogen necessary to start the early generations. Once well established, the microbe begins to manufacture, and may fix from the air as much as two-thirds of the total amount of nitrogen contained in the soil.

Forest soils, especially the sandiest and poorest, abound in leguminaceae, and it is especially in this case, when the soil provides insufficient combined nitrogen, that the plants help themselves

to the necessary quantity by taking it from the air. In many forests on sandy soils, brooms, furze, &c., with Cytisus, Ononis, &c. form a large part of the undergrowth, while on limestone soils, some of the same or other leguminaceae, Calycotoma, Cytisus, Coronilla, brooms, Ononis, Adenocarpus, &c, serve the same purpose. Thus Hellriegel's discovery is of interest to foresters, by pointing to one of the causes which compensate the loss of nitrogen from forest soils.

I think there is, however, a more important and general compensating cause, hitherto ignored, namely, the fixation of nitrogen from the air by dead leaves. In November 1894, in the Forêt de Haye, I gathered off the young oaks and hornbeams, the dead leaves which had not yet fallen to the ground. I dried them first at the temperature of the laboratory, then at 100 °C. The oak leaves contained 9·73 per cent. of moisture, and the hornbeam 12·70 per cent. The nitrogen in the oak leaves was 1·108 per cent. and in the hornbeam leaves 0·947 per cent. Of oak leaves dried at 100 ° C, some 48·96 grammes (equal to 53·130 grammes air-dried) were put into a zinc box 50 c. m. square, having at the bottom a slab of limestone, and at the top a galvanised iron wire netting. Another lot of the same leaves, weighing 53·54 grammes dry at 100 °C, were put into a similar box with a slab of sandstone ("gres bigarre," or "bunter sandstein"). Two other lots of hornbeam leaves, each weighing 43·65 grammes dried at 100 ° C, were put into two other similar boxes.

These boxes were exposed in the open air, on a support 60 c. m. high, protected from any possible emanations from the soil and from any possible source of ammonia. The object of this experiment was a *double one, (1) to study the* relative rapidity of decomposition of the leaves, according as they lay on limestone or sandstone, (2) to follow the qualitative and quantitative changes occurring in both the mineral and organic substances, until their complete conversion to humus. Most interesting to me, among the organic matters were the nitrogenous products.

Given that humification, or the decomposition of dead leaves in presence of air, is essentially due to micro-organisms, as I showed in 1886, and on the other hand, that this decomposition, being active, demands the presence of myriads of microbes, one is led to study their action. Being themselves chemically nothing but little masses of protoplasm, *i. e.* nitrogenous matter, they would probably make good the loss in the leaves by dissipation of gaseous nitrogen. *But if among these* many microbes, there should be any kinds possessing the same precious faculty as that of the nodule microbe, it might be expected that they also would similarly enrich their hosts, the leaves. My experiments showed the latter supposition to be really the case. In December 1895, after being exposed to the air for a year, the oak leaves lying on limestone contained 1·923 per cent, of nitrogen, and the hornbeam leaves on ndstone contained 2·246 per cent. dried at 100 °C. as before.

The gain was thus 0·815 grammes of nitrogen per 100 grammes oak leaves, and 1·299 grammes of nitrogen per 100 grammes of hornbeam leaves. The original percentages having been 1·108 for oak, and 0·947 for hornbeam, it is seen that the amount of nitrogen was about doubled.

During this year, the oak leaves lost 21·62 % of their original weight at 100° C. and the hornbeam leaves 23·01 %. Making the most unfavorable supposition, and granting, what is very unlikely *viz*, that this loss all came from the ternary compounds, and that no soluble ammonical compounds, nitrates, or amides, were formed at the expense of the original nitrogen of the leaves, and carried off by surface waters, the percentage 1·923 being referred no longer to the weight of the leaves in December 1895, but to their weight at the beginning of the experiments, becomes 1·508. Similarly the percentage 2·246 becomes 1·727. The absolute gain of nitrogen then was really 1·508—1·100 = 0·400 % of the original weight for oak, and 1·727—0·947 = 0·780 % for hornbeam.

This gain of nitrogen is very important, since even in the latter case, it reaches half or two-thirds of the original percentage. Assuming that each autumn the soil receives 3,300 kilos of dead leaves, this represents a total of 22·4 kilos of nitrogen from hornbeam leaves, and 13·2 kilos of nitrogen from oak leaves, or about the quantity absorbed in the formation of wood. This greatest cause of nitrogen loss in forest soils is thus at once compensated by the activity of the dead leaves in appropriating atmospheric nitrogen. This capital fact now explains the most general, if not the principal, reason for the well-known and long admitted beliefs that forests not only improve the soil but constitute the only culture which is capable of inducing very poor soils to bear periodic field crops. The leaf covering of the soil, already so highly valued by foresters for its physical and chemical services, thus, by its faculty of appropriating nitrogen from the air, acquires a new claim to our appreciation, now, I believe, brought to notice for the first time.

As already stated, M. Berthelot, in his experiments of 1885, showed the fixation of nitrogen in sands, clays, and mould. In 1868, M. M. Gautier and Drouin stated "that humus, and even 'humic acid made chemically from sugar and acids, are able to 'fertilise soils, either natural or artificially compounded of silica, 'lime, and kaolin, whether with or without vegetation, by enabling 'them to become richer in nitrogen; that the only soils capable of 'fixing the atmospheric nitrogen or ammonia were bare soils con-'taining organic matter, and that humus compounds are a necessary 'condition of this fixation. My experiments, however, refer neither to humus, nor to soil, but to dead leaves still hanging on the branches, and which, though exposed to the air for two years, were in no sense reduced to humus, that is to say, a black and matted substance having lost all trace of vegetable organisation.

The oak and hornbeam leaves were indeed black, but perfectly recognisable. The discovery of M. M. Berthelot, Gautier, and Drouin, that humus, with or without soil, can fix gaseous nitrogen is too limited, and does not cover the whole fact, for the leaf as soon as it is dead, and as long as it preserves its shape, possesses that precious faculty.

Leaves are indeed most admirable organs. All their lives they work hard at the formation of plastic materials necessary for the present and future life of the tree. They die when the external atmospheric conditions no longer permit them to work. But before dying they store up in the tree, in a place of safety, those rare and valuable substances, nitrogen, potass, phosphorus, which in the spring will call into being a new suit of leaves, just as hard-working as their forbears. In falling, they carry with them the smallest possible quantity of these substances, the *caput mortuum* which was incapable of removing itself into the twigs and branches. But even in death they hasten to begin a new work for the tree which produced them. So soon as fine weather comes round they provide food for myriads of micro-organisms, which show their presence and activity by a free evolution of carbonic acid, and which include a certain number which are able to absorb not only oxygen, but nitrogen itself, and utilise it in the constitution of their protoplasm.

The two other boxes, containing oak leaves on sandstone, and hornbeam leaves on limestone, were left for 2 years, from December 1894 to December 1896, exposed to the air. Moreover, in May 1896 I added to each box 50 grammes of fine soil from the Forêt de Haye, after previously ascertaining the quantities of water and organic matter contained. The nitrogen analysis showed results perfectly concordant with the previous ones; 1·73 % in the oak leaves dried at 100° C. on sandstone, and 2·15 % for hornbeam on limestone, or a little less (from 0·1 to 0·2 %) than the previous years figures, that year having been one in which the microbes were rather active. But these figures are still much greater than the original percentages, showing a relative gain of 0·6 %. for oak, and 1·0 % for hornbeam. During these 2 years, the oak leaves lost 29·64 % of their weight, and the hornbeam leaves lost 28·6 % of their weight.

Again, granting, to render the appropriation of nitrogen more conclusive, that the 28 % to 29 % lost included no nitrogenous matters, there was nevertheless an absolute gain of 1·22 − 1·11 = 0·11 % of the initial weight for oak, and of 1·53 − 0·95 = 0·58 % for hornbeam.

Tracing a curve to represent the percentage of nitrogen in a leaf, from its birth to its transformation into humus, it is seen that the fall of the leaf corresponds to a fall, followed by a rise again, due to the appropriation of nitrogen. These are the figures for oak leaves :—

May	...	25·0 per cent. of nitrogenous matters.	(Ebermayer.)
June	...	14·6	
July	...	14·0	
August	...	9·9	
September	...	7·0	
October	...	6·6	
December 1894	..	6·9	
„ 1895	...	12·0	
„ 1896	...	10·8	

Thus, if in nature things proceed as they did in my experiments, the 3·300 kilos of dead leaves, annually falling on to the hectare, contain at the moment of fall 1 per cent. of nitrogen, or 33 kilos of nitrogen altogether, in 206 kilos of nitrogenous substances.

After 2 years, the leaves of oak and hornbeam, which had been exposed, as in the forest, to all the atmospheric influences, lying on a slab of limestone or sandstone, so as to retain moisture as much as possible, were quite black, but perfectly recognisable, both oak and hornbeam, notwithstanding the supposed inferior durability of the latter. They were far from attaining the state of humus.

For the complete exhaustion of the subject, and the removal of all possible doubts, it would be neccessary to isolate the micro-organisms which feed on the leaves and fix the nitrogen, to breed them in pure cultivations, and demonstrate directly their absorptive faculty by the diminution of the definite volumes of nitrogen in which they would be kept, as was done by M. M. Schloesing junr. and Laurent for the leguminous bacteria, but these points are beyond my competence, and can only be elucidated by bacteriologists. I have sent these nitrogen-fixing leaves to M. Macé, who has kindly undertaken to study them.

Among those soil micro-organisms whose nitrogen-fixing *function has been clearly determined, there is, beside the leguminous* bacteria, perhaps only one, the Clostridium pasteurianum, recently discovered by Vinogradsky, which need be mentioned. I can do no better than here give the opinion of an acknowledged master in bacteriology on this subject.

"Vinogradsky starts from the fact that the assimilation of 'nitrogen is a widespread phenomenon in the soil of fields and 'pastures, that there is difficulty in accounting for it by the action 'of a few plants or algæ, and thinks that this assimilation must 'be brought about by microbes, especially by those which are 'satisfied with a medium rich in carbon but poor in nitrogen. 'He has sought for and found them by the method of selective cul-'tivations. Here are his conclusions.

"Out of 10 microbes obtained from soil, not one, not even 'Aspergillus, could assimilate free nitrogen.

"Not one of the microbes could develop in a medium totally 'free from nitrogen, and the Clostridium pasteurianum is in this 'respect unique. It alone can fix enough nitrogen for its needs 'from the beginning to the end of its growth.

"The author allows, contrary to the opinion of M. Berthelot 'that the faculty of fixing nitrogen is not very common in microbe 'society and is a special attribute of one or few species, of which 'one alone, the Clostridium pasteurianum, is at present known."

In the conclusion drawn from a recent study of the same subject, M. Claude Fermi says :—

"Among the micro-organisms studied by me, I found none 'cultivable in solutions of pure saccharose, which were capable 'of fixing nitrogen from the air. In this respect my conclu-'sions confirm those of Vinogradsky."

As for the supposed fixation of nitrogen by certain of the inferior algæ, this action ought to be recognisable in forests where those algæ are found, but it appears not to be due to the algæ themselves, as M. M. Schloesing junr, and Laurent thought, but to the colonies of bacteria which live on them.

"In pure cultivations" says M. Kossowitch, "free from 'bacteria, the algæ do not fix nitrogen. But when exposed to 'light and aided by the bacteria, they can produce the effect 'directly by furnishing the micro-organisms with the hydrocar-'bons necessary to their development. Being better nourished, 'the bacteria develop freely, and consequently fix a rapidly in-'creasing amount of nitrogen."

M. Bouilhac has also noticed that the fixation of nitrogen can occur through the association of certain algæ and bacteria.

Certain authors, like M. Stoklasa of Prague, referring to the assimilation of nitrogen by lupins, even attribute a more effective action to the algæ and bacteria of the soil than to the nodule bacteria.

Though the fact of the assimilation of nitrogen by plants is now beyond dispute, its mechanism is still very obscure. It is but seen darkly, as yet very few are known of those organisms whose function is to compensate the losses of combined nitrogen which are incessantly going on throughout the world. Ten years ago, the only compensatory cause that could be mentioned was the combination of atmospheric nitrogen with the hydrogen of water under the influence of electricity.

Bacteriologists will now find a profitable field for investigation in the dead leaves of the forest, at the time when they are the seat of active decomposition brought about by ærobic micro-organisms, (the class whose technique is at present best understood,) and they will probably soon be able to add a few names to the short list of known nitrogen-fixing microbes.

As the result of my experiments, which are still being continued with varying material and under various conditions, I think I have demonstrated one of the causes, perhaps the most important, cer-

certainly the most general which produce the effect of continuous improvement in forest soils. Owing to the chemical reactions being more prolonged and active in forest then elsewhere, mineral nutritive substances become more plentiful in forest soils. This has long been recognised. But since the acquisition of definite knowledge as to the smallness of the quantities of combined nitrogen supplied by the air, and by rain, &c., it has been difficult to account for the real and ample supply of nitrogen. Thus the forest, the great benefactress, is not content with giving us wood and all its derivatives, a crowd of minor products, the protection of mountains from erosion, the freshness of its shade, and the charm of its greenery, it is also the greatest and the cheapest means available for enriching the soil with two groups of substances as rare as they are necessary, namely nitrogenous matters and mineral nutriment, enabling, with time, but without cost, the poorest soils to supply the needs of agricultural crops.

VI.—EXTRACTS, NOTES AND QUERIES.

The Significance of Afforestation in Preventing and Correcting Torrents.

BY DR. F. FANKHAUSER.

Address delivered before the Bern Forestry Association, June 18th, 1897.

In every forest there are three more or less distinctly marked divisions—the collecting area, the channel course, and the heap of débris. It is in the collecting area that the principal mass of water is gathered which goes to form a torrent. Single drops falling on the topmost ridges flow together down their bare sides in fine thread-like streams and there unite again into larger and larger brooks. While mere drops wash away only earth and sand (thus indeed loosening the hold of larger rocky masses) the brooks overcome stones and coarser material.

Thus even in the collecting area erosion begins. The mass of waters descending on all sides is received in the valley bottom by the channel course. In times of freshets the raging torrent rushes down its narrow bed. The angry flood, weighted with earth, sand and stones, tears away and undermines fresh material from the bed and sides of the torrent. Robbed of their foundation the projecting banks give way and add to the moving débris.

Large slides sometimes block and obstruct the streams until the whole mass, softened by the water, gives away to the pressure and moves on as a so-called "*Muhrgang*" with destructive force, bearing everything before it.

When the torrent emerges from a narrow bed into the level plain or a larger valley, its force diminishes. The rubbish is then heaped up now on one side now on the other into a heap or cone of débris or it may be washed away by a larger stream or river.

The most striking phenomenon in every torrent is its changing amount of water. The Rhine at Basle, for example, varies between its lowest and highest level as one is to twenty. While the Tessin increases from one to one hundred and fifty, and many a torrent with restricted collecting area increases a thousand fold. This is due to the fact that in a bare collecting area scarcely any water is soaked up by the soil. The largest part flows down steep slopes and meets from all sides almost simultaneously in the valley bottom. Demontzey (French general forest inspector) relates that in a certain outburst of the torrent of Faucon in the Lower Alps seventy per cent of the rainfall, or about 65,000 cubic meters of water had flowed off in twenty minutes, carrying away three times this amount in volume of earth and gravel.

The danger of torrents depends on different circumstances. Firstly, as a matter of course, the amount of rain is decisive. Long, persistent rains are more perceptible in the rising of large rivers. In mountain torrents the shorter thunder storms and cloud bursts which last from half an hour and supply an enormous mass of water have more effect.

Storms accompanied by hail are most especially to be feared, tearing up the naked soil, causing mud and stones to be washed away with great ease and force.

The same amount of rainfall will thus have a different effect according to the nature of the soil and lay of the land. The wider the collecting area and the higher up its slopes extend, the greater will be the mass of descending waters, and the steeper the descent the greater will be their velocity and undermining force.

The less power of resistance in the soil the more it is swept away by the water. On this account, we have in Switzerland the most terrible torrents in loose glacial débris.

From what has been said it can be inferred what means are to be used in conquering a torrent. On the one hand we can try to make the stream bed more solid and capable of resistance, and

break the force of the water as much as possible. On the other hand the flow of water in the collecting area can be retarded by a sufficient cover of vegetation which will prevent the starting of floods. The first is accomplished by protective works, the other by afforestation.

The most important aid of a technical description is the "*Thalsperre.*" By means of solid transverse dams, behind which the débris is blocked, the stream is prevented from digging a deeper bed.

At the same time the rate of flow is diminished by these falls, and by leading it into mid-channel the bank is protected from erosion. Various sorts of bank protection serve this purpose. Every impartial observer must admit that in the matter of works for the correction of torrents, we in Switzerland, as well as elsewhere, have accomplished wonders, and the results are most conspicuous.

Many dangerous torrents have been tamed by engineering efforts, to which a large number of places owe the security of life and property against the devastating force of the elements.

But the conquest of a torrent by means of engineering constructions alone has also its dark side. Where a simultaneous improvement of conditions regulating the water sources is neglected, constructions in order to withstand for all time the dashing of powerful floods must not only be built very solidly but must be maintained continuously in their original condition.

This point assumes great importance even where stone suitable for the works is easily accessible, because it is a question of using a passive and perishable means to oppose living forces, which are inexhaustible and constantly operating.

The conditions are especially unfavorable where a durable material is lacking, and wood has to be used for these constructions. Unless constantly under water wood has a minimum durability. Wooden works, as many instances prove, are unfortunately effective only 10 or 12 years. It could easily be computed from works already built and those contemplated what an enormous quantity of wood is required for building and repairs. A large part of the yield of our forests would be necessary to supply material, let alone the exorbitant sums required for construction and maintenance.

This is an evil inseparable from the method of rendering torrents harmless to the mountain regions by means of such constructions alone. But the bad results of this system are equally apparent in the thickly populated fruitful low regions, causing here even greater and more disastrous harm.

On account of the great cost of building and maintaining these works it is generally necessary to confine them to the channel course, and to stop here the main sources of erosion. But as we have seen, erosion begins not here but in the uppermost collecting area.

The gathering of débris is not prevented by the construction, only lessened. Every little side rivulet delivers its quota, and in the course of decades all these washings count up to a considerable quantity. As long as the newly built "Thalsperren" (dams) are not filled up, sand and stone are held fast behind them, and the results are satisfactory. But when the leveling process is complete, the brook then pours at flood times its material over the dam as easily or more so than before it was built. From the brooks the sediment gets into the rivers, and these again when they are treated in like manner carry it off into the low lands. As sediment cannot be dissolved by water it remains where the fall is too slight to carry it further, and causes a raising of the level of the river bed. Thus in 10 years the Rhine bed at Buchs in Canton St. Gallen had risen about a metre. The high water dams must naturally be raised in proportion, and this can go so far that at last the river bed becomes higher than the surrounding country.

It is easy to calculate what eminent danger ensues to neighbouring lands from these conditions, in spite of successive costly raising of the barriers.

But this is not all. As the river rises the level of the underground water also rises until at last the valuable adjacent fields are converted into marsh land, and expensive drainage canals are made necessary. One work leads to another, and yet affords no permanent relief, because instead of holding the débris back among the hills it is only carried further on, and thus at great expense the trouble is shifted from one place to another, not overcome.

You see, gentlemen, that all technical constructions of this sort only aim at providing a barrier. As the French engineer Surell in his famous study of torrents has so aptly said, they are measures of defence, but they do not lessen the power of the waters, they only compel them for a moment to keep certain bounds. Entirely different is the effect of the forest. Of course it is not a question, as many mistakenly suppose, of foresting the overhanging banks and sides of a torrent to prevent undermining and land slides. A wood is as powerless as the soil itself to resist a torrent, and succumbs with the soil to the rush of waters. But in the uppermost collecting area a forest growth holds the accumulations from heavy rain falls and hail storms, and thus prevents the great and sudden swelling of streams.

Only reflect that the leaves of a medium aged beech forest if spread out would cover 8 times the area that the growth in question occupies, and it will be quite apparent that even in the hardest downpours almost one-fifth of the water is intercepted by the foliage, and thence flows slowly down the trunks or passes off in vapour.

Still greater is the quantity of water whtch is taken up by the soil cover, and held fast as though by a sponge.

The small flow from out of a dense forest cover even in heavy rain falls, is so long delayed that a large part trickles into the ground, which in the forest is in a soft and porous state, and also intersected by a network of canals, caused by the decay of roots where trees have been felled, which serve to carry the water rapidly down to lower strata. Quite different is the state of affairs in open country. Here on bare slopes the largest part of a rainfall is obliged to run off over the surface.

If, therefore, we are able partly to stop entirely the flow of water, partly to delay it, we can prevent extraordinary freshets, and as it is only these which cause devastation, and a torrent under ordinary conditions is not productive of any considerable harm, this sort of regulation of the discharge puts an end to the possibility of devastation. We transform a torrent into a woodland brook, which instead of being a curse to the region, thanks to its even and constant water supply, may become a blessing to agriculture and industry.

It will be seen that the torrent to be conquered is attacked by the forester at its source where its forces are as yet scattered, and thus easily tamed. Here by means of forestation we are able on the one hand to retard the water, on the other hand to secure the soil. In this way only is a lasting remedy of the evil possible. If you dispense with this means of help, which nature herself applies when not intercepted by man, the constructive treatment of brooks in every difficult case is only a palliation, and sooner or later retribution follows, unless at the same time the most important cause of freshets is recognized, and the steep slopes of collecting basins, which have been cleared of wood by ruthless stripping, are re-clothed.

I could demonstrate the correctness of this view by countless examples of new forest plantings in Southern France, which, partly with accompanying engineering constructions, partly without them, have been the means of subduing and rendering harmless for all time the most dangerous and devastating torrents.

One of these instances only need here be mentioned.

The *Labouret* is a little valley of 113 hectares in surface extent in the department of Lower Alps, in the collecting basin of one of the tributaries of the Durance.

Up through this valley and at its upper end over the pass of *Labouret* the long and important highway leads from Montpelier to Coni. Previous to 1860 the region in question was entirely barren, so that even the sheep found nothing more to nibble. In every storm the water rushed down the steep naked banks with great velocity ; it dug countless deep gullies in the soil (composed of Lias-Marl), and in the gorge became a resistless torrent which undermined both banks, causing landslides which tore away the roadbed, now here, now there so that traffic was continually interrupted. Conditions were indeed so serious that the *Labouret*

became notorious far and wide as a place of terror. Such reputation may indeed have been well founded, as the engineers knew no other way out of the difficulty than to propose a new route, the cost of which was estimated at 400,000 francs.

This was the situation in the summer of 1862 when the first attempt of the sort in the *French Alps was made*, viz.: the artificial "regazonnement and reboisement" of the *Labouret* (in other words the fixing of the soil by stocking with grass and trees.) In 1874 the principal protective and cultural works were finished, and notwithstanding that no large constructions had been built, all danger for the road was over. To-day, except a few steep hillsides not yet sufficiently afforested, you would find the whole area *clothed with luxuriant thrifty woods, and the* once dreaded torrent of *Labouret* flows over the low dams in the valley bed, a harmless streamlet in the shadow of dense thickets of alders, poplars, ashes, and maples.

Even the severest storms which have since burst upon the region have only caused a moderate rising and muddiness of the waters and every danger of washing away has entirely disappeared.

This is only an example on a small scale, but it is applicable for extended water sheds, as great freshets are only made up of a series of small torrents each one of which can be treated in a similar manner.

In the Western Cevennes for example, in the department of Herault, there are two rivers, the *Orbe* and the *Jaur*. During a freshet on the 12th of September, 1875, within a few hours, 150 *dwellings* were destroyed and 100 lives lost, causing a total damage valued officially, at over three million francs.

In September, 1890, there occurred in the same department still more fearful rainfalls and floods. The vineyards alone in the plain on the lower course of the Herault suffered a loss of 15 million francs, not to mention other extensive devastations. In the collecting areas of the *Orbe* and the *Jaur, where meantime extended* new forest plantings had been carried out, no appreciable erosion took place. Washing away of débris was this time insignificant, and the water remained comparatively clear.

You see, gentlemen, from these instances how far the beneficial effects of well-wooded mountain regions extend, and what extraordinary interest we have in Switzerland on behalf of the low country between the Alps and Jura, *that the forests in the mountains* should be properly managed, and where necessary newly laid out on a large scale. Mistakes and failures here will be fatal, not only for the immediate surroundings, but for the whole country. The benefits of our Federal law relating to the forest administration in high regions are by no means confined to these regions only, but in a still greater degree are felt by the thickly settled low lands, and there *is absolutely no foundation for the* assumption that the mountain regions were favored at the expense of the

low regions. Quite the contrary is the case. The law imposes considerable hardships and sacrifices upon the mountain populations ; it restricts the right of control over their own forests by limiting the minor products, such as wood pasture and gathering of litter, and it enforces many other regulations which for the most part decidedly benefit the low country, and not the mountain inhabitants.

The Federal contributions for afforestation are therefore only an equitable and by no means an adequate indemnification for the sacrifices made in behalf of the whole country.

Perhaps it would be of interest to learn exactly what areas should be afforested. Although nothing can be formulated in a few words which would be invariably applicable, it may be stated that the forestation of a fertile and productive area becomes necessary in proportion to its steepness.

The greater the number of steep bare slopes in the collecting area of a torrent, the more dangerous is it, and the more extended should be the afforestation. That the formation and composition of the soil is a point to consider goes without saying, but the valuation of the land in question must also be included in the calculations. Where it is worth two or three thousand francs per hectare, it may be better economy to extend the engineering works, and to decrease afforestation correspondingly.

You see therefore, gentlemen, that what the forestry folk recommend is not a reckless transformation of valuable agricultural land into forest. Only the least desirable areas in the uppermost regions are demanded. This last point is indeed of consequence. Afforestation must reach to as high an attitude as climatic conditions will possibly admit of, if possible, to the topmost ridge of a steep collecting area.

Further down where the land pays better, the area of afforestation may be restricted, and in the valley bed it need hardly extend beyond the immediate shores on both sides of the stream. On the other hand, after the torrent is tamed, the pile of débris as well as the land won from the river and secured for culture may be entirely released and restored to agriculture as compensation for the worthless surfaces appropriated in the high regions. It is very important then, in the treatment of a collecting area, that the furthest ramifications of a torrent should, first of all and as rapidly as possible, be covered with a forest growth, and at the same time the small protective works carried out. The amount of necessary outlay for works in the lower sections of the stream depends upon the effects produced by these newly wooded regions.

It seems especially requisite to undertake such plantings without delay where the corrective works are to be principally of wood, so that these may not decay before the beneficent effects of the newly created forest are apparent.

Considering expenditures in this connection, what relation do afforestation and protective works bear to one another in Switzerland? In spite of every effort on the part of cantonal and Federal forestry officials the area afforested with State aid since 1871 only amounts to less than 3,000 hectares, and according to the sum of expenditures the relation of afforestation to corrective works is about as one million to sixty-three and a half million francs.

Compare with this what France has accomplished since 1893. Fifteen million francs have been expended for purchase and forestation of 62,000 hectares of barren land, not to mention the many other plantings undertaken by private persons and communities with State aid. Only eight million francs have gone towards works of correction. This amount, together with expenses for roads, transport, buildings, etc., makes only 46 per cent. of the *total* expenditure for constructions and corrections as against 98 per cent. consumed by us for similar ends.

Do you not think, gentlemen, that France has spent her money more advantageously than we in Switzerland? Every outlay for constructive works is like a debt contracted, unless simultaneous forestation is undertaken which will render them needless in the future. The continuous expense of maintenance and renewal corresponds to the interest on the debt. Sums which are spent for the increase of forest area are on the contrary not a debt, but capital well invested. From such a policy you may expect not only the most perfect protection, but in the end a considerable and from year to year increasing income.

In regard to the comparative amounts expended in Switzerland for corrective works and afforestation, it must be remarked that if the outlay has not hitherto accomplished its purpose the authorities should not be held responsible. Assistance is forthcoming whenever it is sought, and wherever forestation is indicated the necessity of undertaking it is invariably recommended, but I could give you countless examples of communities and corporations to whom the matter of subduing a torrent is a vital issue, who obstinately refuse to resort to cultures on their own ground and property, notwithstanding that most liberal appropriations are available for defraying the expenses.

The cause of the evil lies in the insufficient enlightenment of the people as to the real interests of the country. It seems, therefore, an important and worthy undertaking for the Bern Forestry Society to start a propaganda for the forestation of the collecting areas of our torrents, and for each member in his own neighbourhood to work for the accomplishment of this object.

The Forester.

The Floss, or "Silk-Cotton," of Calotropis procera.

Calotropis procera is a shrub found in the drier parts of India, chiefly in the sub-Himalayan district, from the Indus to Jhelum; in Central India and the Deccan; and distributed to Persia and tropical Africa. *Calotropis gigantea*, a species only doubtfully distinct from *C. procera*, and which has the same vernacular names, is recorded as identical in its properties and uses. The sap yields a form of gutta-percha, and is also used as a tan and dye; a manna is said to exude from the plant; the bast fibre and floss from the seeds are well-known fibres; the root-bark and sap are medicinal; the wood is used for gunpowder charcoal; and various parts of the plant are employed for sacred, domestic and agricultural purposes.

These plants, *C. procera* and *C. gigantea*, yield two distinct fibres—(1) a silk cotton from the seeds, known commercially as "madar floss," and (2) a rich, white, bast fibre from the bark. The floss is soft, very white, and has a beautiful silky gloss; it is employed to some extent, like the Dutch "kapok," for stuffing pillows, but has generally been regarded as of too short staple to be spun, although, as regards its possible use in this direction, a Lancashire spinner stated, at the time of the Colonial and Indian Exhibition of 1886, that he had overcome the difficulties, and was prepared to purchase any quantity. But, as the plant is only found wild, scattered over a wide area, the supply is limited and irregular. If it can be cultivated there seems to be no reason why a regular supply should not find a market at a remunerative price, and, at the same time, by bestowal of attention to the cultivation and selection of seed, the character of the floss might be improved and its length of staple increased.

The attention of the Scientific Department of the Institute having been directed by the Government of India to the possible utility of this floss, it has been submitted to examination by Mr. C. F. Cross, Scientific Referee on Fibres to the Imperial Institute, and the following results have been obtained. The more important constants of the fibre, which has the chemical characteristics of lignocellulose, are as follows:—

Moisture	...	9·0 per cent.
Ash ...	...	3·0 " "
Hydrolysis	(Alkali, 1 per cent. $NaOH$),	26·2 per cent. (loss)
	(Acid, 1 per cent. H_2SO_4),	24·7 " " "
Cellulose	... ...	69·8 per cent.
Furfural	... ...	19·5 " "

Mr. Cross states that this floss fibre is an extremely interesting chemical type, containing as it does a very high and, in his experience, unique percentage of furfural. He is of opinion,

however, that although use may be found for some applications of floss fibre, its somewhat unfavourable chemical characteristics are not likely to recommend it to the spinner, in view of the present low price of cotton.

The floss has also been submitted to the Expert Referee to the Institute on Fibres, who has reported that this floss was in considerable demand in the markets a few years ago for fancy textile purposes, but that, owing to the difficulties presented by the variations in the quality of the parcels supplied, and to the intermittent supply when requirements arose, the material has dropped out of use. The quality of the Indian growth has, so far, proved inferior to the product of Java, which is probably derived from *C. gigantea*, and of which small samples have occasionally been received from India. The present specimen was of fair colour, of rather short staple, somewhat towy in character, and contained an excessive quantity of inferior, immature fibre, and seed fragments. Many varieties of the floss in question have been dealt with, most of them from Calcutta, where it is sometimes called "akund cotton," which were usually inferior to the present sample. These samples were sold at as low a price as one penny per pound, and there was but little demand for them at that price. The trade in this floss might possibly be revived if a moderate and continuous supply could be guaranteed. If of good quality, it would realize prices ranging from 4d. to 5d. per pound (c. f. & i. terms). In packing for sale, the floss should be handled as little as possible, the pods and seeds being entirely removed and the floss left in its natural condition—unopened; any discoloured portions should be removed and forwarded separately. The bales received here from Java usually contain 80 to 90 pounds of floss tightly sewn in canvas, but not pressed.—*Imperial Institute Journal.*

A New "Tallow Tree."

The French Journal, *Revue Coloniale*, gives the following description of a new tallow tree:—The *Myristica surinamensis. Roland*, of Guiana, and the *Myristica Kombo H. Bn.*, of the Congo, yield a fatty substance very closely allied to tallow, which has caused the name of "tallow tree" to be given them. The tree to which we now draw attention, however, belongs neither to the same species nor to the same family. The tallow tree of East Africa must be placed in the family of *Guttiferæ*; at first the name of Stearine-tree (*stearodendron*) was given to it, and this was afterwards changed to Allanblackia. The *Allanblackia Stuhlmanii, Engler*, known in Usambara under the native name of Msambo, is a tall tree, whose rather large fruit-buds, fleshy and of a strange

shape, immediately attract the attention of the traveller. The fruit which attains the size of a human head, contains a considerable number of seeds, which are extraordinarily rich in a fatty substance. It is stated that the seeds of four of these fruits will yield as much as 1 to 1½ kilogrammes (say 2 to 3 lb.) of fat. This fat is of the same stiffness as tallow, and can be used for making candles. At Bagamoyo, indeed, this trade has reached considerable proportions. The wood of the tree, which is of a red colour, could be utilized in house-building, and perhaps even for cabinet-making.—*Imperial Institute Journal.*

Erythrina indica.

Writing to the Journal of the Bombay Natural History Society with reference to a paper by Mr. Woodrow on the plants of a Bombay swamp, Surgeon-Captain Prain remarks:—"I am interested in what he says of Erythrina indica as appearing in your Bombay swamps and as having more the appearance of a wild tree than other examples near Bombay have. The truth is that Erythrina indica is one of the commonest of Indian sea-coast trees all round the found Andamans, Nicobar and Burmese Coasts, and all along the sea-face of the Sunderbuns, it is one of the very commonest species, but *nobody ever found it truly wild anywhere except on a sea-coast.*" It may interest him to know that the tree is not infrequently in the dry hills of the Prome District in Burma. Kurz (Forest Flora of British Burma I. 369) says "strange enough, this sea-shore tree scantily re-occurs in the dry forest of the Prome District. I have not examined the respective localities, but suspect that there are brine wells or limestone in the vicinity." There is no doubt about its being really wild as it occurs in virgin forest miles away from any village. The tree is also reported to be wild in the Khandeish Dangs, and Brandis says that it occurs wild in the *Gonda forests of Oudh.*

The introdnction of Ladybirds and other enemies of Insect Pests.

The Government of Madras has recently had under consideration a proposal made by the Hon'ble Mr. H. P. Hodgson to introduce ladybirds from Australia with a view to the destruction by their means of red spider and scale bugs. Mr. Hodgson has offered to guarantee half the expense incurred if Government will take up the matter.

According to an article which lately appeared in *Nature*, the entire eradication of the white scale insect has been effected in California by the importation from Australia of its ladybird enemy, *Vedalia cardinalis*, and the citrus industry of the State has thereby been saved. In 1891 the same State granted 5,000 dols for the purpose of sending an expert to Australia, New Zealand and the adjacent countries to collect and import parasitic and predaceous insects. The expert chosen was Mr. Albert Koebele who had previously introduced the *Vedalia cardinalis*; during the year he was employed he succeeded in introducing 60,000 specimens of different species but principally ladybirds. Most of these have disappeared but a few of them are still abundantly represented in the orchards of California, the most important being three different species of *Rhizobius*. These are said to have already done much good. One species *R. ventralis*, has been distributed in enormous numbers to different parts of the State and in some instances has effected the entire eradication of the black scale in badly infested orchards.

The particular ladybird which Mr. Hodgson purposes to introduce is *Chryptolœmus Montronzieri* which Mr. Koebele says has proved most valuable in Honolulu. Mr. Hodgson further suggests that as various crops suffer from insect pests and each insect probably has its natural enemy, it would be worth while employing an entomologist to take up the question generally.

The Government of Madras consider that in view of the decided opinion expressed by the Commissioner of Agriculture, Hawaii, that the work of searching for and introducing the natural enemies of insect pests "should be entrusted only to a skilled entomologist, one who has made the life habits of beneficial and injurious insects a special study, lest injury instead of benefit might arise," it is unsafe to apply for or introduce ladybirds from Australia except under the professional advice and supervision of an expert; but that if, when the services of such an expert are procured, the latter advises that a consignment of these insects should be obtained, they will be ready to take the necessary action in the matter and to contribute half the cost as proposed by Mr Hodgson.

We would suggest that before indenting on Australia for new species, the Madras planters should experiment with some of the numerous indigenous ladybirds, which might prove as efficacious as imported kinds.

The Camphor Tree.

An account of the range, cultivation, uses and products on he Camphor tree (*Cinnamomum Camphora*) is given in a Circular (No. 12) just distributed by the United State Department of

Agriculture (Division of Botany). Notwithstanding the comparatively narrow limits of its natural environment, the camphor tree grows well in cultivation under widely different conditions. It has become abundantly naturalised in Madagascar. It flourishes at Buenos Ayres. It thrives in Egypt, in the Canary Islands, in South Eastern France and in the San Joaquin valley in California, where the summers are hot and dry. Large trees at least two hundred years old, are growing in the temple courts at Tokyo where they are subject to a winter of seventy to eighty nights of frost, with an occasional minimum temperature as low as 12° to 16 ° F. The conditions for really successful cultivation appear to be a minimum winter temperature not below 20° F., 50 inches or more or rain during the warm growing season, and abundance of plant food rich in nitrogen.

In the native forests in Formosa, Fukienand, Japan, camphor is distilled almost exclusively from the wood of the trunks, roots, and larger branches.

The work is performed by hand labour, and the methods employed seem rather crude.

The Camphor trees are felled and the trunk, larger limbs, and sometimes the roots, are cut into chips which are placed in a wooden tub about 40 inches high and 20 inches in diameter at the base, tapering towards the top like an old fashioned churn. The tub has a tight fitting cover which may be removed to put in the chips. A bamboo tube extends from near the top of the tub into the condenser.

This consists of two wooden tubs of different sizes, the larger one right side up, kept about two-thirds full of water from a continuous stream which runs out of a hole in one side.

The smaller one is inverted with its edges below the water, forming an air-tight chamber. This air chamber is kept cool by the water falling on the top and running down over the sides. The upper part of the air chamber is sometimes filled with clean rice straw, on which the camphor crystallises, while oil drips down and collects on the surface of the water. In some cases the camphor and oil are allowed to collect together on the surface of the water and are afterwards separated by filtration through rice straw or by pressure.

About twelve hours are required for distilling a tubful by this method. Then the chips are removed and dried for use in the furnace, and a new charge is put in. At the same time the camphor and oil are removed from the condenser. By this method 20 to 40 pounds of chips are required for one pound of crude camphor.—*Nature.*